

A HANDBOOK
OF THE
BRITISH SEAWEEDS

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WITH 270 FIGURES IN THE TEXT



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PREFACE

The need of an up-to-date book on British Seaweeds is obvious from the fact that the last complete account was published about sixty years ago. Accordingly, Dr. A. B. Rendle, Keeper of the Department of Botany, arranged with Dr. L. Batten (now Professor L. Newton) to prepare this Handbook of British Seaweeds, and saw the first part of it through the press.

For various reasons there has been considerable delay in its publication, but it is to be hoped that the book has in no way suffered from this. Dr. Newton has studied seaweeds for several years and has here attempted to give an account of the whole of the British species in as simple language as possible. In this work she has had access to the very extensive British collections of specimens and slides in the Department.

The basis of the arrangement is "A Catalogue of the British Marine Algae" by E. A. L. Batters, which has long been out of print. In all, about 260 genera and 750 species are described. The drawings, which are a special feature of the book, were made for the most part by the late Mr. Percy Highley, though a few are by Professor Newton.

In the present state of our knowledge and with increasing activity in the subject, it is obvious that the Handbook can be regarded only as a forerunner of monographic studies, but students have now a general account of British seaweeds, the absence of which has doubtless prevented many from taking up the study of this interesting group of plants, and has also hindered the development of taxonomic knowledge.

The Handbook has been seen through the press by members of the Staff of the Department. Special mention is due to Mr. G. Tandy, whose knowledge of the taxonomy and nomenclature of algæ has been freely at the disposal of the author.

J. RAMSBOTTOM.

Department of Botany, November 1931.

I wish to record my deep gratitude to my late husband for his unfailing encouragement during the preparation of the text, and to Mr. A. Gepp for information, advice and help.

L. NEWTON.

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INTRODUCTION

THE algæ belong to the Thallophyta, a group of plants without the differentiation of a shoot into axis and leaf which is characteristic of the higher forms of plant-life. They have been divided into groups, on the basis of colour-difference, the Cyanophyceæ usually being blue-green, the Chlorophyceæ green, the Phæophyceæ olive-green to brownish black, and the Rhodophyceæ red or purple. Of these the Rhodophyceæ and Phæophyceæ are usually confined to salt or brackish water, but the Chlorophyceæ and Cyanophyceæ inhabit both fresh and salt water. The algæ occurring in salt or brackish water round the shores of the British Isles are alone included here.

Occurrence.—The coast of the British Isles, varied in character and irregular in outline, provides suitable conditions for a very extensive algal flora which clothes the shore between the tide-marks and the rocks below the tide-level. Some of the plants of the littoral region are exposed at low-water, while others find shelter in rock-pools which are left by the receding tide. In sandy bays a few are able to persist, but they are restricted mostly to species which bind the sand together and so obtain a firm hold-fast. Muddy estuaries have a characteristic but sparse algal vegetation, and some species are able to grow among the flowering plants of the shores of the estuaries. On rocky coasts a few algæ may occur so far above the normal high-water mark as to be reached only by the spray or by a tide of exceptional height in stormy weather.

The change in the algal vegetation from one part of the coast to another may be gradual, or very sudden where a sharp bend in the coastline completely changes the conditions. It is probably due not only to the mechanical action of the waves but to the fact that the water is richer in oxygen and more nutritive where it surges on a steep, rocky coast.

The same species of alga will often vary considerably according to its habitat. This is particularly well seen in *Chondrus crispus*, which has a much-divided narrow frond or a broad thallus with undulated margins, dependent on the conditions under which it grows. The thallus of *Laminaria digitata* remains undivided in stagnant water but becomes digitate in free-flowing water. Furthermore, various Fuci growing in muddy estuaries change their character so much that it is difficult to be certain of the species to which they belong, as, for example, on the mud flats

near the mouth of the Artro in W. Wales, where some of the Fuci form a mossy carpet among the flowering plants.

Methods of collection and preservation.—In collecting marine algæ it is well to equip oneself with wading boots, as the best collecting grounds are usually below low-water mark or in rock-pools. The surface of mud and the bases of the stalks of salt-marsh vegetation should not be neglected, as they are the habitats of many of the smaller algæ. Dredging is very useful for obtaining many of the deeper-water forms; arrangements for this can usually be made at any Marine Biological Station. Marine algæ tend to decay very rapidly and considerable care is necessary in collecting. A vasculum is useful for the larger plants, together with sheets of grease-proof paper in which to wrap specimens as they are collected. A little camphor placed among the packets helps to prevent decay and retains specimens in the best condition for examination. Glass tubes should be used for small specimens which may be placed in a small quantity of sea-water. When plants are to be examined cytologically the following solution is suitable for fixing: 25 c.c. of 1 per cent. chromic acid; 10 c.c. of 1 per cent. glacial acetic acid; 65 c.c. of sea-water, with subsequent washing in sea-water. For general work a solution of 4 c.c. of 40 per cent. formalin in 96 c.c. of sea-water is usually satisfactory.

Most algæ make satisfactory herbarium specimens. After gathering they should be washed quickly in fresh water, except the larger Phæophyceæ, which should be soaked in fresh water for three or four hours to prevent their retaining a coating of salt. The smaller species can be floated in dishes of sea-water and a selection made of the specimens, which should then be washed in fresh water and mounted on thick unglazed paper. The plant is best removed from the water by placing the paper under it and then slipping a glass plate or sheet of perforated zinc beneath the paper, which can be held in an inclined position and the plant spread out with the aid of a fine brush or mounted surgical needle. The paper is then removed from the glass plate and put on a piece of blotting-paper, resting on a pad of newspaper. A thin piece of butter-muslin, previously washed to remove the "dress," is placed over the plant and covered with another piece of blotting-paper and a pad of newspaper. A pile of algæ may be made in this way and kept firm in a press or beneath a biscuit-tin full of sand. The drying papers should be changed daily for a week, and after that two or three changes should be made until the plants are dry. Many algæ adhere to paper, others need to be painted on one side with Higgins' Vegetable Glue or some other clean adhesive.

Distribution.—One of the main factors affecting the distribution of algæ is the securing of a suitable holdfast. Rough rocks

carry better crops than smooth boulders. When the tilt of the strata is great there are usually few plants except species of *Porphyra* on the smooth faces, while the irregular edges are clothed with luxuriant vegetation. This same difficulty of obtaining a holdfast has no doubt led to the development of epiphytism in a degree only paralleled elsewhere in a tropical forest. An excellent example of the effect of the substratum is seen in comparing the rough stipe of *Laminaria Cloustoni*, which is completely clothed in summer with a mass of epiphytic vegetation, with the smooth one of *Laminaria digitata* where it is possible only for a few procumbent algæ to attach themselves. Occasionally epiphytism has given place to parasitism and the relation between host and parasite is one of the many interesting problems which confront the algologist.

Zonation.—In addition to the differences in the amount and the type of vegetation on various parts of the coast, there is the distribution or zoning of the algæ at any one place, as one passes from high to extreme low-water mark. As early as 1820 D'Orbigny tried to bring together data to show that the common occupants of the shore occurred in regular succession. On the whole, the red algæ grow at the greatest depth, the brown occurring in the main in places exposed at every tide or only partially exposed at the lowest tides. The blue-green and green algæ occur high up where they are exposed at every tide or left in shallow rock-pools. The presence of rock-pools upsets the general sequence because it enables plants that would otherwise occur at greater depths to persist nearer high-water mark. The shallow pools near high-water mark become very warm in summer, and the number of species which are able to exist under these conditions is very limited. Nearer low-water mark the vegetation becomes more luxuriant, and below half-tide the plants of the pools are varied and abundant. On the rocky bottom *Halopitys pinastroides* and *Polysiphonia* spp. are abundant with species of *Gelidium*, *Griffithsia*, *Laurencia* and *Lithothamnion* if there is sufficient shade. The edges are often lined with *Lithophyllum lichenoides* and *Cystoseira ericoides*, the latter being beautifully iridescent in the sunlight. Still lower, *Nitophyllum* spp. are found, and *Calliblepharis* sends up hooked branches which climb among other algæ. *Chylocladia articulata*, *Ptilota plumosa* and *Plumaria elegans* line the rocky sides of deeper pools, the submerged parts being clothed with the pink and mauve incrustations of Corallines.

Light is probably one of the important factors in algal distribution. In northern countries, such as the Faroes, where fog is most frequent at the period when the sun's altitude is greatest, the algal vegetation is limited to a depth of thirty fathoms. The passage into a cave exhibits a rapid succession, the vegetation inside usually consisting almost entirely of red algæ. Gaidukow

has shown that the distribution is not so much due to the intensity of the light as to its composition. The epiphytes on the stipes of *Laminaria Cloustoni* grow in a very regular order from above downwards. This again would appear to be due to light intensity. Light also appears to influence the colour of red algæ, those growing in deep water or in the shade being a much brighter red than the mid-littoral members of the same group.

The large brown algæ occur in very regular succession on any one shore, but their actual position varies very much under different conditions and some zones may be entirely absent. The order is most commonly *Pelvetia canaliculata*, *Fucus spiralis*, *Ascophyllum nodosum*, *F. vesiculosus* and *F. serratus* near the *Laminaria* zone. A certain amount of work has been done on the causes of this zonation.

Some of the plants are exposed at every tide and must be able to withstand desiccation. As Baker has shown, three phases of the life-history of members of the Fucaceæ might be influenced by drying: (1) Germination. (2) Vegetative growth. (3) Reproduction and dispersal of the gametes.

She carried out experiments with *Fucus spiralis*, *Ascophyllum nodosum*, *F. vesiculosus* and *F. serratus*, which showed that species occupying the highest zones can germinate and become attached under all conditions, but species growing in lower zones will not germinate under the conditions occurring in the highest zones. *Ascophyllum nodosum* is the only species in which exposure to the air appears to be essential to the expulsion of gametes. In all other Fuci considerable dehiscence takes place even when they are not exposed. The ability of young plants of various species to withstand desiccation was tested by growing them under conditions of exposure to which they were not accustomed. Those occurring near high-water mark resist desiccation better, grow more slowly and absorb water more slowly than those growing near low-water mark. Algæ obtain their nourishment by absorbing water through the thallus, and thus the plants nearest high-water mark will have less available food and slower growth. *F. spiralis* appears to have a definite physiological adaptation. It does not grow properly unless it is dry for part of the time.

Uses.—In the British Isles the use of seaweed is not now as extensive as it was. In the Channel Islands the larger brown algæ are used for manuring agricultural land, and in the Western Hebrides *Fucus vesiculosus* forms part of the winter food of cattle and sheep.

In S. Wales fish-wives at the weekly markets used to sell laver-bread (*Porphyra*) liberally sprinkled with oatmeal. It was usually served with bacon for breakfast, made into small flat cakes and fried crisp in the bacon fat or heated with butter, lemon-juice and pepper and served with roast mutton. In some

places green laver (*Ulva latissima*) was used. When gathered it was washed in several pools to remove the sand, and was then boiled before being brought to market. *Chondrus crispus* or *Gigartina mamillosa* forms "Carragheen," or "Irish Moss." This is bleached and dried and then made into a "shape" with milk and sugar and some flavour such as nutmeg or essence of lemon. A preparation of Carragheen is now on the market. In some parts of Scotland *Rhodymenia palmata* (Dulse) and *Alaria esculenta* (Tangle) are still used as food.

The most important use of seaweeds has been the production of "ash" by the burning of *Laminaria digitata*, *L. Cloustoni*, *L. saccharina*, *Ascophyllum nodosum*, *Fucus serratus* and *F. vesiculosus*. The Laminarias yield "drift-weed kelp" when they are washed up after storms, the other algæ growing within the tidal range are cut from the rocks at low water. The plants are dried in the sun and then collected in shallow pits and burnt. When the mass is still hot it is broken up by sprinkling with water. It takes some twenty or more tons of wet weed to yield one ton of ash, the average composition of which is—

Potassium sulphate	..	..	..	10-12 per cent.
Potassium chloride	..	..	..	20-25 "
Sodium carbonate	..	..	..	5 "
Other salts of sodium and magnesium	..	..	..	15-20 "
Insoluble ash	..	..	..	40-50 "

At one time this ash from kelp was the principal source of sodium carbonate, and was also used for the extraction of potassium salts. After the introduction of the Leblanc process for the manufacture of sodium carbonate the value of the kelp decreased considerably, but the industry was subsequently helped by the increase in the demand for iodine, of which kelp was at first the only commercial source. The yield of iodine from the kelp varies very considerably. Good drift-kelp will yield 10-15 lbs. per ton, while cut-weed kelp will yield from 3-4 lbs. only. Much of the iodine used to be lost owing to the rough preparation, but a method was devised by which the weed was treated by destructive distillation. The mother-liquor remaining after the separation of the less soluble salts by crystallisation with manganese dioxide and sulphuric acid was subsequently distilled. The development of the Stassfurt salt-mines for the production of potash salts has been a further cause of the depression in the kelp industry.

Classification.—The basis of the separation of the main divisions of the algæ is the presence or absence of certain pigments; the four main groups are—

1. MYXOPHYCEÆ (Cyanophyceæ).

The Myxophyceæ are characterised by the presence of a blue pigment, phycocyanin, in addition to chlorophyll, the combina-

tion of the two pigments giving the organisms a blue-green appearance. They may be either single or colonial unicellular plants, or the cells may be united into branched or unbranched filaments. The cells are variously shaped with a simple structure, a thin cell-wall being present surrounded by a tegument of varying thickness and consistency. The tegument may be gelatinous or cartilaginous, and may be either structureless or stratified in various ways. It frequently forms a sheath enclosing one or more rows of cells known as trichomes. Multiplication takes place either by cell-division or by the formation of asexual spores, sexual reproduction and zoospore formation being unknown in the group. Multiplication by cell division consists in the separation of single cells (coccogonia) or of short filaments known as hormogonia. This difference is used as the main basis of division into orders within the group. Asexual spores are formed within a cell which has been known as a gonidangium. The structure is really a sporangium and gives rise to large or small numbers of spores. Reproduction may also take place by the formation of thick-walled resting spores.

II. CHLOROPHYCEÆ.

The Chlorophyceæ contain the pigments chlorophyll, carotin and xanthophyll. The thallus ranges from a microscopic individual to a plant more than a metre in length. It may be formed of a single uninucleate cell as in *Protococcus*, a colony of such cells as in *Prasinocladus*, or made up of a number of uninucleate or multinucleate cells united together into a branched or unbranched filament or a flattened lamina. In the Ulotrichales, Ulvales and Schizogoniales the individuals are composed of uninucleate cells, while in the Siphonocladiales and Siphonales they are respectively septate and aseptate cœnocytes. The cell-walls are frequently mucilaginous and laminated, and the plastids vary considerably both in shape and number. They frequently contain pyrenoids. Vegetative reproduction takes place by cell-division, by fragmentation and by the production of gemmæ. Asexual spores are produced and may be motile or non-motile, the latter being either aplanospores, that is spores which are formed inside the wall of the original cell, or akinetes, in which the outer wall of the original cell forms part of the wall of the spore. In addition sexual reproduction may take place by the fusion of iso- or heterogametes, resulting in the formation of a zygote. The thallus may be either haploid or diploid, and there is an alternation of generations in some members of the class.

III. PHÆOPHYCEÆ.

The Phæophyceæ vary in colour from olive-green to dark brownish black. The cells contain numerous plastids in which there is a brown pigment, fucoxanthin, in addition to the more

usual carotinoid pigments associated with chlorophyll. There is considerable variety in form and structure within the group. The thallus may consist of a corticate or ecorticate monosiphonous filament, a flat mono- or polystromatic frond, or a complex pseudoparenchymatous soma exhibiting marked division of labour and specialization of function. Three principal modes of growth have been distinguished—

I. Growth from a single apical cell. This may result in many forms of thallus. In its simplest form it produces a filamentous corticate or ecorticate thallus as in *Sphacelaria* and *Sphacella* respectively. It may give rise, however, to a flattened lamina with a complicated structure. In *Fucus*, for example, the apical cell is depressed, while in *Dictyota* it divides longitudinally at an early stage so that a dichotomously branched thallus results.

II. Simultaneous growth of several contiguous filaments at their tips, resulting in a flattened expansion as in *Myrionema* or a globular body as in *Leathesia*.

III. Intercalary growth as in *Laminaria*, where there is growth at the point of union between lamina and stipe, the new lamina growing upwards from the base and gradually pushing off the old blade. In *Scytosiphon* intercalary growth also occurs, but it takes place at the base of the plant above the attachment organ.

Vegetative reproduction may take place by the formation of propagulae as in *Sphacelaria*, asexual reproduction by the formation of oval zoospores, pointed at one end, furnished with two cilia laterally attached, one directed forwards and one backwards during movement. Sexual reproduction takes place by the fusion of ciliated gametes or by the fertilisation of non-motile eggs by ciliated sperms. There is a definite alternation of generations in some families. In *Laminaria* spp., for example, the zoospores give rise to a filamentous structure bearing either oogonia or antheridia. The filament may consist of a single cell or of a branched multicellular body.

In the Dictyotaceae there is a well-marked alternation of generations. Tetraspores are produced, the reduction division being the first division in the tetrasporangium. Each tetraspore produces a thallus bearing sexual organs.

In the Fucaceae that phase of the life-history which culminates in the production of sexual cells has been shortened so that the sexual reproductive bodies are really homologous with the zoospores of the Laminariaceae, but they are not discharged until after the formation within them of either eggs or sperms.

IV. RHODOPHYCEAE.

The Rhodophyceae are red or deep purple when growing normally. In shallow bays where very few genera are able to exist the plants become greenish, as e.g. *Chondrus crispus*, which will grow in shallow pools exposed to a great deal of light.

The thallus varies from a branched or unbranched monosiphonous filament to a pseudoparenchymatous expanded thallus, but the anatomy is not usually as highly developed as in the Phaeophyceae.

In 1883 and 1897 Schmitz separated the Rhodophyceae into two main groups, the first containing the Bangiales, the second the Nemalionales, Cryptonemiales, Gigartinales and Rhodomeniales. In 1923 Kylin examined the procarpial and auxiliary-cell conditions and separated the Gelidiales on account of the absence of an auxiliary cell. The Bangiales differ in vegetative characters from the Florideae in their intercalary growth and in the absence of pores between the cells. In the Florideae protoplasmic connection between the cells is very clearly established.

In many of the Rhodophyceae there is a marked alternation of generations, the sporophytic generation bearing tetraspores and the gametophyte bearing carpospores and spermatia either on the same or on different plants. The tetraspores are formed by the division of a single cell into four parts, the first nuclear division in the tetrasporangium being the reduction division. The divisions may be at right angles to one another giving cruciate spores as in *Rhodochorton*, parallel to each other giving zonate spores as in *Corallina*, or they may be arranged as in Fig. 193 B, when they are said to be tetrahedral. The tetrasporangia may be isolated on the thallus as in *Callithamnion*, grouped together on branchlets as in *Ptilota*, in chains in adjacent cells as in *Polysiphonia*, or grouped in wart-like masses or nemathecia as in *Melobesia*.

Sexual reproduction takes place by the fertilisation of the egg cell by a non-ciliated sperm known as a spermatium. The spermatia are borne singly in cells which may occur in groups on the surface of the flattened thallus, be borne in short dense tufts or in siliculose branchlets, or developed on the surface of irregular disc-like branches as in *Chondria*. The female organ before fertilisation is known as a procarp, and is usually borne near the surface of the younger parts of the thallus. The upper portion of the procarp is elongated into a slender hyaline hair called a trichogyne to which the spermatia become attached. After fertilisation, the cells at the base of the trichogyne divide and in the simplest case the divisions grow into short filaments which ultimately form chains of carpospores. The spores may be enclosed in an envelope as in *Polysiphonia*, or they may be naked as in *Nemalion*. The development of the carpospores from the fertilised egg is one of the most complicated processes in the algæ. It has been made the basis of classification of the Florideae, but much further investigation is needed. After fertilisation subsequent fusion occurs between the fertilised egg and the other cells, which may be lateral cells of the carpogonial branch as in *Callithamnion*, or cells of certain modified branches in other parts

of the frond as in *Dudresnaya*. Such fusions doubtless lead to more efficient spore-nutrition.

Reduction division may take place immediately after fusion, as in *Nemalion*; or it may be postponed until tetraspore-formation.

Summary.—An examination of these four main divisions shows that the vegetative thallus of the marine algæ varies from a single cell in some of the Myxophyceæ and Chlorophyceæ to a complex highly differentiated structure in both the Phæophyceæ and Rhodophyceæ. Many of them show a division of their life-histories into two definite cycles, at the end of one of which comes the production of spores, at the end of the other that of sexual cells. In proceeding from the simple to the more complex forms there is frequently a tendency for the shortening of the stage which culminates in the formation of sexual cells, so that the one producing spores plays a more important part and the sexual stage often becomes parasitic upon it. The development of the eggs and sperms in *Fucus* may be interpreted in this way. In others, as for example in *Saccorhiza*, there is a large elaborate thallus which bears the spores, and these germinate to form a filamentous structure on which the sexual organs are borne, two generations being on distinct plants. Fertilisation *in situ* has not been definitely established in the Phæophyceæ, although the egg does not always leave the cell which bore it when some of the Laminariaceæ are grown in culture. In the Florideæ, however, fertilisation *in situ* has become established, but, as Church has shown, one of the main points of interest in this group is that the plants appear to present a succession of *three* generations according to the scheme—

I. Gametophyte with sexual organs and fertilisation *in situ*, the parasitic zygote becoming a

II. Carposporophyte bearing unilocular monosporangia and dispersing *diploid* carpospores. The latter germinate to a

III. Tetrasporophyte which is a free autotrophic individual, producing unilocular sporangia each of which gives one tetrad of four spores. During the formation of the tetrad meiosis takes place and haploid tetraspores result. Such haploid spores germinate to give a haploid soma which may be sexual and will then repeat the sequence.

The development of the cystocarp and the way in which the developing spores are fed, are the most important bases of classification in the Florideæ. The pit-connections between the cells and the mechanism of secondary pit-connections enable the young carposporophyte to avail itself of the food supply of the parent plant. On the other hand, when the tetraspores are borne in the carposporophyte, as in *Phyllophora Brodiaei* and *Gymnogongrus Griffithsiae*, the haploid phase is parasitised by the diploid.

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BRITISH SEaweEDS

MYXOPHYCEÆ

(Cyanophyceæ)

Key to Genera.

1. Colonies rarely filamentous; vegetative reproduction by single cells (coccogonia) ... 2.
- Colonies filamentous; vegetative reproduction by groups of 2 or more cells (hormogonia) 12.
2. Colonies not filamentous; asexual reproduction by resting spores 3.
- Colonies globular or irregular, distinctly filamentous at times; asexual reproduction by endogenous gonidia 8.
3. Cells solitary or united in small indefinite colonies without mucilaginous intercellular substance binding the cells together *Chroococcus* (p. 3).
- Cell division transverse, mucilaginous tegument present 4.
- Cell division in 3 planes, mucilaginous tegument present 5.
4. Colony regularly plate-like, cells spherical or nearly so *Merismopedia* (p. 7).
- Colony irregular, cells elongate, not in regular rows *Aphanothece* (p. 7).
5. Membrane of successive generations persistent, older enclosing younger as stratification 6.
- No distinct stratification in gelatinous membrane enclosing colony 7.
6. Colony round, solid or tubular, sheath thick, irregularly striate *Oncobyrsa* (p. 5).
- Colony irregularly shaped or encrusting, cells in twos or multiples of two *Glœocapsa* (p. 4).
7. Colony enclosed in thin mucilaginous layer *Aphanocapsa* (p. 3).
- Colony enclosed in thick mucilaginous layer *Anacystis* (p. 6).
8. Cells solitary or gregarious, no transverse cell division except in spore formation *Dermocarpa* (p. 8).
- Cells with transverse division 9.

9. Colonies subspherical or tubercular, cells
with only indistinct arrangement..... Pleurocapsa (p. 10).
Cells seriate 10.
10. Forming an extended stratum from which
short vertical groups of cells arise Entophysalis (p. 11).
Cells not forming an extended stratum 11.
11. Cells in elongate branching series Hyella (p. 11).
Cells in short unbranched series Chamæisiphon (p. 13).
23.
12. Spores or heterocysts, or both, present 13.
Spores and heterocysts absent 13.
13. Terminal hairs present Amphithrix (p. 31).
Terminal hairs absent 14.
14. Sheath present 16.
Sheath absent, or exceptionally very evanescent 15.
15. Trichomes twisted into distinct spiral Spirulina (p. 14).
Trichomes straight or sometimes in loose
irregular spiral..... Oscillatoria (p. 15).
17.
16. Trichomes single in the sheath 21.
Two or more trichomes in a common sheath 18.
17. Trichomes simple 20.
Trichomes pseudo-branched 19.
18. Sheaths distinct, not mucous nor diffuent ...
Sheaths diffuent uniting filaments into sub-
membranaceous stratum Phormidium (p. 18).
19. Tips of filaments uniting into erect tufts..... Symploca (p. 21).
Filaments loose or matted, not in erect tufts 21.
20. Filaments free Lyngbya (p. 22).
Filaments ascending and fasciculate, forming
tufted layers Plectonema (p. 25).
21. Filaments scattered, relatively few in a sheath
Filaments many, forming dense strand in
sheath Symploca (p. 21).
22. Sheath wide, mucous, diffuent and adherent
Sheath narrow, firm, free Microcoleus (p. 26).
23. Trichomes alike at both ends Hydrocoleum (p. 28).
Trichomes unlike at opposite ends Schizothrix (p. 29).
24. Filaments free or adherent, but in no definite
form 24.
Filaments united into colonies of definite
form with firm epidermal layer 26.
25. Cells discoid 25.
Cells globose to cylindrical Nostoc (p. 43).
26. Terminal hairs present Nodularia (p. 46).
No terminal hairs present Anabæna (p. 44).
27. Branching false, hairs usually present and
abundant 27.
Branching both true and false, hairs present,
occasional or abundant Microchæte (p. 41).
28. Sheaths free, not diffuent 28.
Sheaths diffuent into an enclosing jelly 31.
29. Trichomes single in a sheath 30.
Trichomes several in a sheath Calothrix (p. 32).
30. Trichomes radiating from the base in a
globular or lobed thallus Dichothrix (p. 35).
Trichomes parallel in a flattened thallus ...
31. Sheath diffuent into gelatinous thallus; not
boring Rivularia (p. 38).
Sheath not diffuent; shell or calcareous rock
borers Isactis (p. 35).
- Brachytrichia (p. 41).
Mastigocoleus (p. 40).

Order I.—COCCOGONALES

Thallus unicellular, or in non-filamentous colonies, free-floating or attached. Multiplication by direct cell-division, by division of specialised gonidangia into small non-motile gonidia, or by both methods.

Family I.—CHROOCOCCACEÆ

Cells varying in shape and size, attached or free-floating, having a gelatinous or mucilaginous tegument, sometimes highly coloured. Multiplication by vegetative cell-divisions in one, two or three planes, the cells separating immediately or remaining in colonies.

1. **CHROOCOCCUS** Naeg.

(Gr. *chroos*, colour, and *kokkos*, a berry.)

Cells single or united into spherical or flattened colonies of 2, 4 or 8 cells, contents blue-green, violet or yellowish; tegument not gelatinous, comparatively thin in many species, that of the original cell sometimes enclosing the entire colony; division in 3 planes.

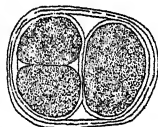


Fig. 1.—*Chroococcus turgidus* Naeg. Colony ($\times 530$). (After G. M. Smith.)

C. turgidus Naeg.—Cells spherical, ellipsoidal or somewhat angular, 1–4, rarely 8, in a colony, 13–25 μ , rarely 40 μ in diam.; tegument often lamellate, hyaline; cell-wall thin, not distinct; protoplast bright blue-green, granular.

In fresh and brackish water along high-tide line. Probably common; Norfolk.

2. **APHANOCAPSA** Naeg.

(Gr. *aphanes*, invisible, and *kapsa*, a box.)

Cells spherical or angular by mutual pressure, single or colonial; walls thick, soft, joined by an amorphous homogeneous mucilaginous layer. Cell-division similar to that of *Glaucocapsa*.

A. marina Hansg.—Colony small, green, gelatinous, sub-globose; peripheral cells oblong or rarely sub-globose, 6–7.5 μ by 5 μ , often in pairs; thin lax mucilaginous layer, cell-wall delicate.

On *Cladophora* and Corallines. Probably common.

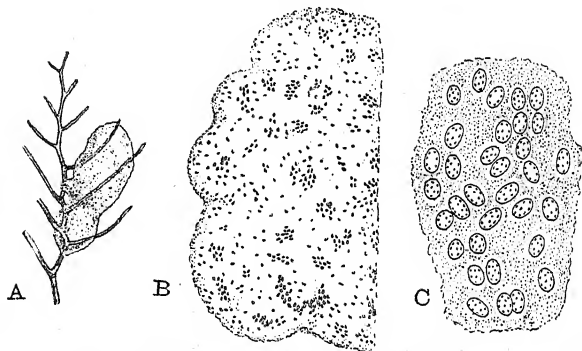


Fig. 2.—*Aphanocapsa marina* Hansg. A. On host ($\times \frac{2}{3}$); B. Colony ($\times 63$); C. ($\times 300$).

3. GLÆOCAPSA Kütz.

(Gr. *gloios*, sticky, and *kapsa*, a box.)

Cell-divisions in all directions; cells spherical with thick walls, solitary or united into groups, surrounded by a gelatinous tegument, generally in concentric layers round each cell and also round the whole colony.

G. crepidinum Thur. Lat. *crepido*, a bank or pier.—Cells spheroidal, yellowish, 3.5μ by 5μ or more in diam., imbedded

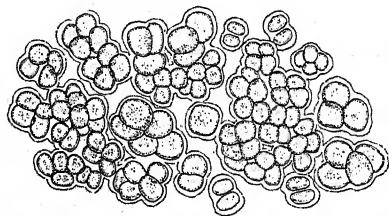


Fig. 3.—*Glæocapsa crepidinum* Thur. Colony ($\times 430$.)

in an olive-brown gelatinous tegument, occasionally single, usually united into twos or a multiple of 4.

On rocks and woodwork near high-water mark. Probably common; widely distributed.

4. **ONCOBYRSA** C. A. Agardh

(Gr. *onkos*, a tubercle, and *bursa*, skin.)

Colony roundish, solid or hollow, gelatinous, consisting of spherical or elongated cells, irregularly arranged or in more or less regular radial rows.

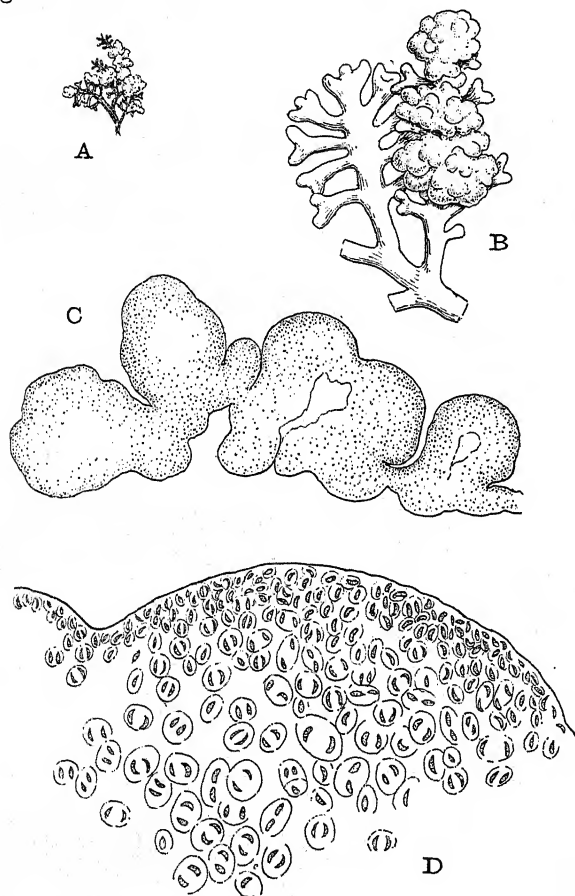


Fig. 4.—*Oncobyrsa marina* Rabenh. A. Colony on host ($\times \frac{2}{3}$); B. ($\times 6$); C. Portion of colony ($\times 60$); D. ($\times 300$).

O. marina Rabenh.—Colony small, green, gelatinous, sub-globose; peripheral cells oblong or rarely sub-globose, $6-7.5\mu$ by 5μ ; cells of the interior sub-globose or curved; lax, mucilaginous coat thin, cell-wall delicate.

On *Cladophora* and Corallines.

5. **ANACYSTIS** Menegh.(Gr. *ana*, up, and *kustis*, a blister.)

Cells spherical to oval; protoplast blue-green or violet, associated into spherical or lobed and irregular colonies; cell-wall thin; copious gelatinous tegument, within which the cells may be uniformly distributed or segregated into small groups; cell-divisions in all planes.

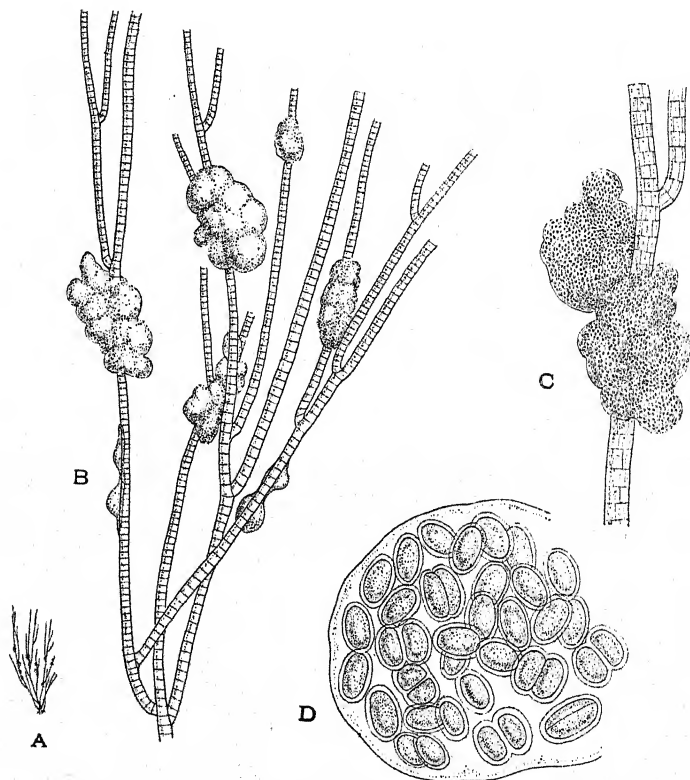


Fig. 5.—*Anacystis parasitica* Kütz. A. Colony on host ($\times 3$); B. ($\times 45$); C. ($\times 65$); D. ($\times 600$).

A. parasitica Kütz.—Colony small; cells oval, bluish green, arranged in several layers so as to form a solid mass; cells 6μ by $8-9\mu$.

On small algæ in shallow pools near high-water mark. Probably common; widely distributed.

6. **APHANOTHECE** Naeg.

(Gr. *aphanes*, invisible, and *theke*, a case.)

Cells variable in shape but elongate; wall thick, united in a mass of homogeneous jelly; similar to *Aphanocapsa*, but differing in having transverse divisions.

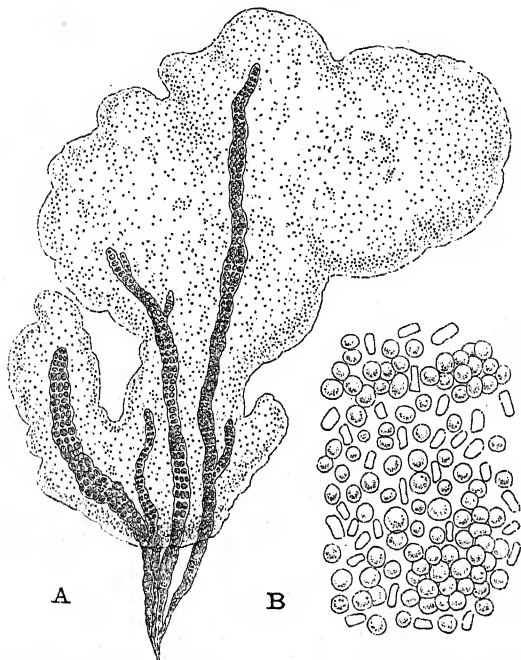


Fig. 6.—*Aphanothece pallida* Rabenh. A. Colony on host ($\times 80$); B. Cells of colony ($\times 600$).

A. pallida Rabenh. Lat. *pallidus*, pale.—Gelatinous, soft, pale green, sub-hyaline; colony 4–6 mm. thick; cells oblong-ellipsoid or cylindrical, $3-8\mu$ in diam., $1\frac{1}{2}$ –3 times as long as broad, mostly scattered, with separate teguments.

On rocks among brown algæ. Probably common; Dorset.

7. **MERISMOPEDIA** Meyen

(Gr. *merismos*, division, and *pedion*, a plain.)

Cells spherical or narrow ellipsoidal; cell-walls thin; teguments firm, hyaline, structureless, binding the cells together; division in 2 planes; colonies at first square or regularly rectangular, later often irregular in outline.

M. glauca Kütz. Lat. *glaucus*, bluish grey.—Colony square or rectangular, bluish grey; margin entire or sinuous-crenate;

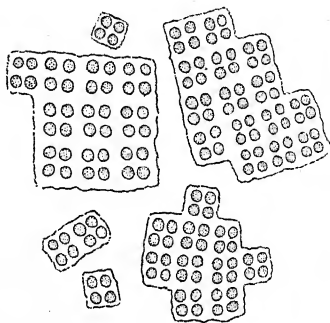


Fig. 7.—*Merismopedia glauca* Kütz. ($\times 560$).

16-64 cells in each colony (rarely more), $45-150\mu$ broad; cells oval or globose, $3-6\mu$ broad, enclosed in a thick gelatinous layer. Probably common; Cumbræ.

Family II.—CHAMÆSIPHONACEÆ

Thallus usually unicellular, distinct or associated into non-filamentous colonies; when pluricellular, with a more or less chroococcoid basal prostrate portion and an erect portion; cells ovoid, pyriform or cylindrical, always with a distinction between base and apex; usually epiphytic. Reproduction by gonidia which are cut off successively from the upper part of the mother-cell, or produced by the division of the cell-contents by three or more sets of division planes.

1. DERMOCARPA Crouan

(Gr. *derma*, skin, and *karpos*, fruit.)

Cells usually epiphytic, spherical, ovoid, pyriform to narrowly cuneate, occasionally single, but mostly aggregated into dense clusters, often very crowded; protoplast blue-green, brownish or violet; cell-wall comparatively thick, hyaline. Reproduction wholly by gonidia.

Key.

- | | |
|-----------------------------------------|---------------------------|
| 1. Cells wedge-shaped or pyriform | 5. |
| Cells round, ovoid or cylindrical | 2. |
| 2. Cells cylindrical | <i>D. incrustans</i> (6). |
| Cells ovoid or spherical | 3. |
| 3. Clear rose-pink | <i>D. rosea</i> (5). |
| Not rose-pink | 4. |

- | | |
|-------------------------------------------------------------------------|----------------------------|
| 4. Cells spherical..... | <i>D. Schousboei</i> (1). |
| Cells ovoid | <i>D. Leibleiniae</i> (2). |
| 5. Protoplast reddish violet | <i>D. violacea</i> (3). |
| Protoplast not reddish violet | 6. |
| 6. Radiating wedge-shaped cells forming hemi-
spherical colony | <i>D. prasina</i> (4). |
| Cells single or in irregular groups | <i>D. Leibleiniae</i> (2). |

1. **D. Schousboei** Born. After P. K. A. Schousboe, Danish botanist.—Cells spherical, united into hemispherical masses. Fertile cells globose, sessile, containing a large number of nearly round spores.

Epiphytic on small algæ, in shallow pools near high-water mark, often in company with *D. prasina*. Not uncommon widely distributed.

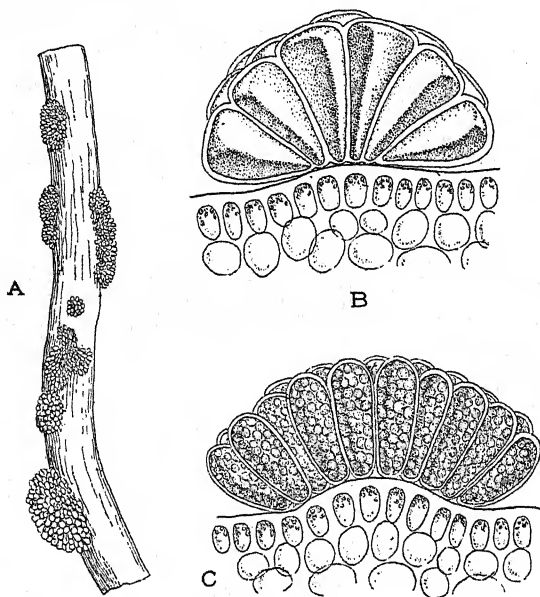


Fig. 8.—*Dermocarpa prasina* Born. A. On host ($\times 60$); B. Single colony ($\times 450$); C. showing gonidia ($\times 450$).

2. **D. Leibleiniae** Born. *Leibleinia*, a genus of algæ.—Cells ovoid and elongate, ellipsoid or pyriform, $8-20\mu$ thick, single or in groups; cell-wall often striate; protoplast olive-green, inclining to blue or brown. Contents of reproductive cells dividing by a cross-wall, the upper half, rarely the lower, forming gonidia.

Epiphytic on smaller algæ.

3. *D. violacea* Crouan.—Cells pear-shaped, 8–28 μ in diam.; cell-wall thin; protoplast reddish violet; gonidia completely filling the reproductive cells.

Forming spots 3–5 mm. diam., on other algæ. Rather rare, but widely distributed.

4. *D. prasina* Born. Lat. *prasinus*, grass-green.—Cells wedge-shaped, united into hemispherical green or olive-green masses radiating from the base; gonidia small and green, entirely filling the reproductive cells.

Epiphytic on *Catenella Opuntia*, *Laurencia pinnatifida* and other small algæ. Common.

5. *D. rosea* Batt. Lat. *roseus*, pink.—Possibly only a variety of *D. violacea*, distinguished by the ovoid cells and clear rose-pink colour, forming indefinitely expanded patches, 2.5–5 cm. in diam.

Rare; Berwick and Dunbar.

6. *D. incrustans* Batt.—Cells 9.5–13 μ by 1.5–2 μ , rounded at the base and apex, adhering closely together forming an encrusting layer of irregular shape; contents homogeneous, rusty green; membrane distinct, thin, striated.

On *Sphacelaria*, *Laurencia pinnatifida* and other algæ. Not uncommon; widely distributed.

Similar in form to *D. prasina*, but having cells more cylindrical.

2. PLEUROCAPSA Thur.

(Gr. *pleura*, broad, and *kapsa*, a box.)

Cells spherical or angular, united into more or less gelatinous colonies of various shapes formed by cell-divisions in three planes; protoplast blue-green to yellowish or violet. Reproduction by vegetative cell-divisions and by gonidia.

Key.

Cells 2–4 μ in diam.	<i>P. fuliginosa</i> .
Cells 10–13 μ in diam.	<i>P. amethystea</i> .

P. fuliginosa Hauck. Lat. *fuliginosus*, sooty.—Forming a thick dark encrusting layer on wood and rocks; colonies 5–100 μ in diam., of 2–4 cells, or occurring singly, with colourless tegument and homogeneous golden, reddish brown or dark violet contents.

Rare; widely distributed.

P. amethystea Rosenv.—Vegetative cells dull violet, round when solitary, somewhat angular when colonial, 10–13 μ in diam.; colony hemispherical or sub-globose, 45 μ or more in diam.; cell-divisions in three planes; gonidia minute, 1–2 μ diam.

On *Rhizoclonium riparium* and other algæ. Rare; Wales and Guernsey.

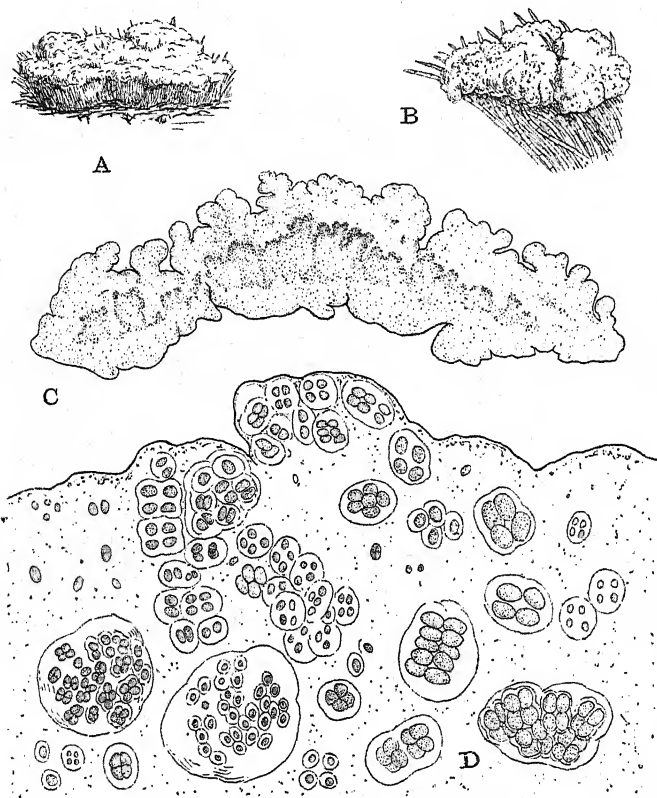


Fig. 9.—*Pleurocapsa fuliginosa* Hauck. A. Colony ($\times 3$); B. ($\times 6$); C. ($\times 30$); D. Colonies ($\times 430$).

3. ENTOPHYSALIS Kütz.

(Gr. *entos*, within, and *phusallis*, a bladder.)

Cells united into colonies, which assume a dendritic form; encrusting, enveloped in a gelatinous tegument.

E. granulosa Kütz.—Encrusting layer about 1 mm. thick, blackish brown; gelatinous tegument brownish; cells spherical or angular, $2-5\mu$ thick; colonies forming tree-like masses, creeping on stones between the tide marks.

Rare; Sussex.

4. HYELLA Born. & Flah.

(After F. Hy, French algologist.)

Forming indefinite patches, boring into mollusc shells or into algæ; primary or basal filaments mainly extended horizontally;

one or more cells enclosed within a sheath with frequent true branching; short secondary filaments composed principally of longer, narrower cells in a separate sheath, arising from the basal filaments; cell-divisions in all directions. Reproduction by the escape of vegetative cells from the sheaths, and by gonidia, formed by the successive division of the contents of gonidangia,

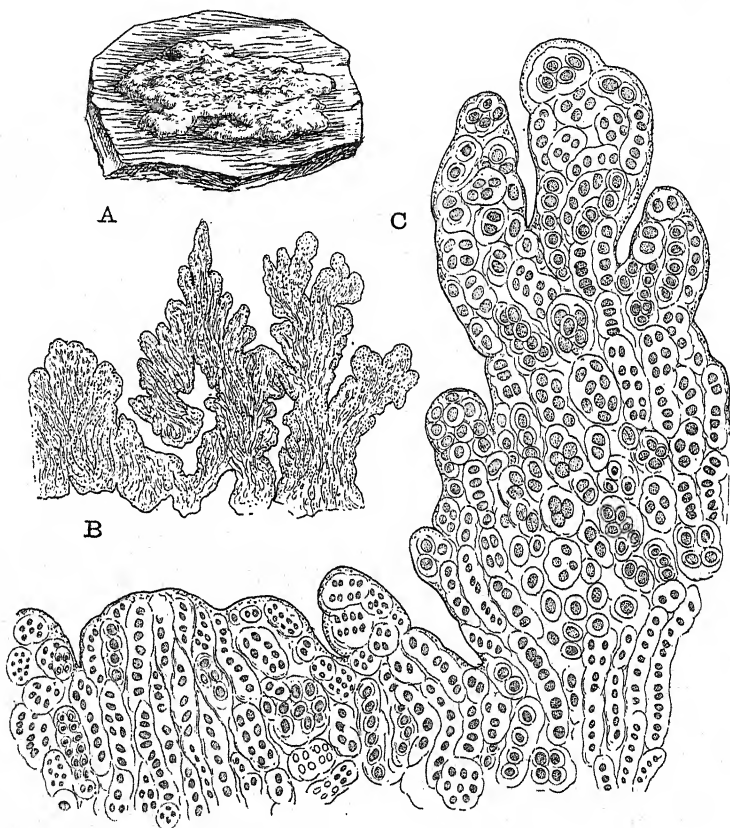


Fig. 10.—*Entophysalis granulosa* Kütz. A. Colony ($\times 3$); B. ($\times 33$)
C. ($\times 300$).

developed on short branches of the basal filaments, or by the modification of cells of the basal filaments.

H. caespitosa Born. & Flah. Lat. *caespitosus*, tufted.—Appearing as minute discolorations on shells, later becoming expanded and forming confluent patches ultimately covering the outer part of the shell, which then appears rough; erect filaments usually parallel, 5–6 or even 10μ in diam., 100–200 μ

long; lower cells shorter, upper ones several times as long as broad, sometimes branching; sheaths hyaline, horizontal filaments much branched, composed of spherical or angular cells, often several rows in a sheath; protoplast yellowish olive-green

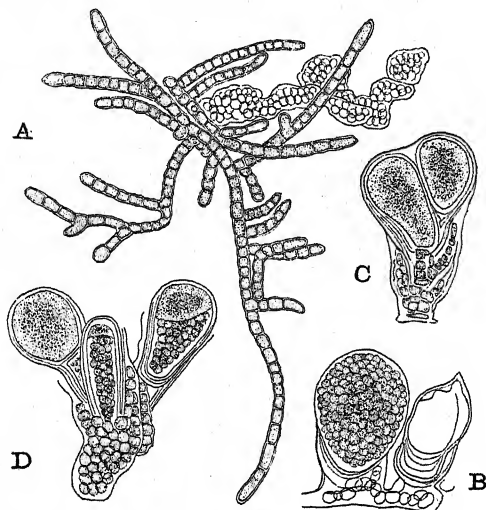


Fig. 11.—*Hyella caespitosa*. A. ($\times 220$); B., C. and D. reproductive filaments from non-decalcified shells ($\times 220$). (After Bornet and Flahault.)

or blue-green. Gonidangia formed by the modification of cells towards the base of the filament, ovoid or pyriform; gonidia numerous, spherical, about 2μ in diam.

Boring into the shells of Mollusca. Common.

var. *nitida* Batt. (*H. voluticola* Chodat).—Clear purplish pink, more slender than the type. Rare; Plymouth Sound and Coast of Wales.

5. CHAMÆSIPHON A. Br.

(Gr. *chamai*, on the earth, and *siphon*, a tube.)

Microscopic, often parasitic, erect, more or less rigid, solitary or in groups, never colonial; individuals vaginate, cylindrical, clavate or pyriform, dividing transversely; contents blue-green or dark violet; sheath stipitate at the base, hyaline; apices eventually open. Reproduction by unicellular gonidia, often unequal in breadth, non-motile, developed in basipetal succession by transverse or rarely longitudinal divisions.

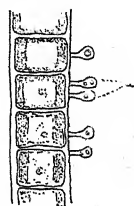


Fig. 12.—*Chamæsiphon marinus* A. Br. Epiphytic on *Ulothrix* ($\times 500$).

C. marinus Wille.—Minute, erect, solitary, 0.5μ in diam., surrounded by a well-defined wall; later in gonidia formation divided by a series of transverse walls; sheath inconspicuous, completely surrounding the cell.

Epiphytic on *Ulothrix submarina*. Probably common; Dorset.

Order II.—HORMOGONALES

Thallus pluricellular, filamentous, with or without a sheath, cylindrical or tapering into a hair, unbranched, or with false or true branching; filaments single, several within a common sheath, or united into a gelatinous mass; cells of the filament similar or with occasional heterocysts. Reproduction by the filament breaking into segments a few cells long (hormogonia), and by the formation of resting spores.

Suborder I.—HOMOCYSTINEÆ

Filaments either floating free or in layers, usually entirely unattached to the substratum; trichomes of cells homogeneous, not tapering to a hair, simple or branched; heterocysts absent; gelatinous sheath present or absent. Reproduction by hormogonia; spores unknown.

Family II.—LYNGBYACEÆ

Trichomes pluricellular, straight, arcuate or spirally twisted, simple or rarely with false branching, cylindrical or attenuate at the apices; cells homogeneous, with or without a sheath. Multiplication by hormogonia.

Subfamily I.—SPIRULINOIDEÆ

Filaments without a sheath, more or less regularly or irregularly coiled in a spiral.

1. SPIRULINA Turp.

(Lat. *spirula*, a small spiral.)

Trichomes multicellular, without a proper sheath, cylindrical, coiled into a more or less regular spiral, apices usually not tapering, terminal cell rounded, without calyptra; protoplast homogeneous or granular.

Key.

- | | |
|---------------------------------------------|---------------------------|
| 1. Spiral closely twisted | <i>S. subsalsa</i> (3). |
| Spiral lax | 2. |
| 2. Colonies bright blue-green | <i>S. major</i> (1). |
| Colonies violet-purple and blue-green | <i>S. versicolor</i> (2). |

1. **S. major** Kütz. (*S. pseudotenissima* Batt., *S. Hutchinsice* Harv., non Kütz.) Lat. *major*, larger.—Colonies bright blue-green; trichomes pale blue-green, more or less flexuose, $1.2-1.7\mu$ in diam., usually twisted into a loose regular spiral, with a distance of $2.7-5\mu$ between the turns; occasionally tight spirals occur. Rare; Northumberland, Wales and Cumbrae.

2. **S. versicolor** Cohn, var. *laxa* Gom. Lat. *versicolor*, particoloured.—Forming a thin mucilaginous layer, violet-purple and blue-green when alive, entirely blue-green when dry; substance soft, filaments $1.2-1.8\mu$ broad, twisted into lax spirals.

Rare; Devonshire.

3. **S. subsalsa** Oersted (*S. tenuissima* Kütz.) Lat. *sub*, somewhat, *salsus*, salted.—Filaments intricately interlaced, $3-5\mu$ in diam., hyaline; spiral closely twisted, cell-divisions scarcely visible, oscillations rapid.

Forming a blue-green or yellowish green stratum on mud or floating among other algæ. Not uncommon.

var. **oceanica** Gom. (*S. oceanica* Crouan).—Filaments 1μ in diam., twisted into a regular tight spiral. Rare; Dorset and Norfolk.

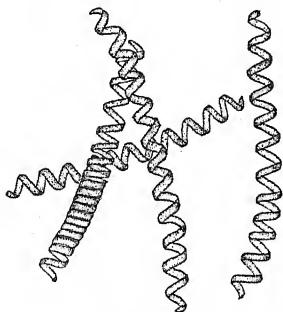


Fig. 13.—*Spirulina major* Kütz. ($\times 900$.)

Subfamily 2.—OSCILLARIOIDEÆ

Trichomes always simple, straight or at times in a loose more or less regular spiral, destitute of a distinct sheath.

1. OSCILLATORIA Gom.

(Lat. *oscillare*, to swing.)

Trichomes free, often forming tangled masses, cylindrical, sheath absent or delicate, smooth or constricted, not moniliform, straight or arcuate, not spirally twisted; apices straight or uncinat, more or less tapering, terminal cell of some species with thickened membrane. Distinguished from *Phormidium* and *Lyngbya* in being destitute of a distinct sheath.

Key.

- | | |
|----------------------------------------------------------------------------------------------------------------------|----|
| 1. Trichomes not markedly attenuate at the apex | 2. |
| Trichomes attenuate at the apex | 6. |
| 2. Trichomes torulose, frequently more than 11μ broad, apices obtuse, arcuate, sometimes completely spiral | 3. |

- Trichomes not more than 11μ broad, apices not arcuate; protoplast homogeneous, dissepiments frequently obscure *O. amphibia* (5).
3. Trichomes twisted into a regular spiral *O. Bonnemaisionii* (1).
Trichomes not spirally twisted 4.
4. Trichomes $17-29\mu$ in diam. *O. margaritifera* (2).
Trichomes $6-11\mu$ in diam. 5.
5. On mud and rocks; trichomes straight *O. nigroviridis* (3).
Epiphytic; trichomes flexuose *O. Corallinæ* (4).
6. Filaments reddish purple *O. rosea* (10).
Filaments some other colour 7.
7. Apices long and gradually attenuate; articulations $1\frac{1}{2}$ to twice as long as broad *O. subuliformis* (6).
Apices sharply attenuate, obtuse or acute; articulations equal in length and breadth or shorter 8.
8. Articulations 3 times as broad as long, swollen cells at intervals *O. brevis* (9).
Articulations equal in length and breadth or $\frac{1}{2}$ as long as broad 9.
9. Cells $3-5\mu$ in diam., protoplasm with fine evenly distributed granules *O. lætevirens* (7).
Cells $4-6\mu$ in diam. protoplasmic granules few or absent *O. formosa* (8).

1. *O. Bonnemaisionii* Crouan (*O. colubrina* Thur., *O. intermedia* Crouan). After T. Bonnemaision, French algologist.—Trichomes pale olive-green, somewhat regularly or loosely twisted, very flexible, slightly torulose, $18-36\mu$ in diam.; apices not markedly attenuate; end wall of terminal cell convex, not thickened; cells $3-6\mu$ long; protoplast granular.

Rare; S.E. Scotland.

2. *O. margaritifera* Kütz. (*O. insignis* Thwaites). Lat. *margarita*, a pearl, *fero*, I bear.—Trichomes bright olive-green, forming dark masses or mixed with other algæ, very flexible, torulose, $17-29\mu$ in diam., arcuate at the ends; apical cell slightly attenuate, obtuse, capitate, furnished with a slightly convex calyptra; cells $3-6\mu$ long, large granules distributed in the protoplasm along the cross walls.

On mud and salt marshes. Probably not uncommon; Gloster, Cornwall and Cumbrae.

3. *O. nigroviridis* Thwaites. Lat. *niger*, black, *viridis*, green.—Forming dark olive-green layers; trichomes nearly straight, fragile, torulose, $7-11\mu$ in diam., slightly arcuate at the extremities; end cell-wall very convex, slightly thickened; cells $3-5\mu$ long, with two rows of granules at the cross walls.

In pools or salt marshes. Probably not uncommon; Gloster, Cumbrae and Berwick.

4. *O. Corallinæ* Gom. *Corallina*, a genus of algæ.—Trichomes aggregated into a thin dark olive-green stratum or mixed with other algæ, densely intertwined, flexuose, torulose, $6-10\mu$ in diam.; apices somewhat arcuate, very slightly attenuate; cells 2-3 times shorter than their diameter; protoplast sometimes con-

taining scattered granules, not crowded at the cross-walls; apical cell subcapitate, with slightly thickened convex terminal wall. Usually epiphytic.

5. *O. amphibia* C. A. Agardh (*O. infectoria* Tassi.).—Trichomes forming a thin pale blue-green layer at the bottom of quiet water or floating on the surface, straight or somewhat contorted, fragile, not constricted at the partitions, $2-3\mu$ in diam., terminal cells not attenuate or capitate, outer cell-wall rounded; cells

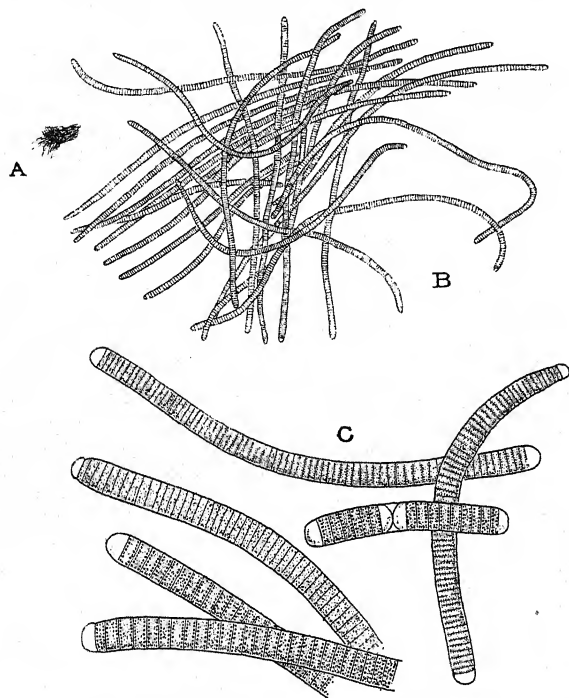


Fig. 14.—*Oscillatoria margaritifera* Kütz. A. Colony ($\times 1$); B. ($\times 60$); C. ($\times 300$).

2-3 times as long as broad; protoplast homogeneous except for 2 granules near the obscure dissepiments.

Rare; Berwick.

6. *O. subuliformis* Thwaites. Lat. *subuliformis*, awl-shaped.—Stratum thin, bright blue-green, appearing black in the water; trichomes delicate, gradually attenuate towards the apices, subacute, arcuate; dissepiments inconspicuous, articulations $\frac{3}{4}$ as long as broad; protoplast homogeneous, not visibly granular.

On mud, subsequently floating. Rare; Gloster, Berwick and Cumbræ.

7. *O. lætevirens* Crouan. Lat. *læte*, joyfully, *virens*, green.—Trichomes associated into a delicate deep blue-green membrane; single filaments yellowish green, straight, delicate, slightly constricted at the dissepiments, 3–5 μ in diam.; apices straight or uncinat; terminal cells obtuse or subacute; cells 2.5–5 μ long; protoplast with fine evenly distributed granules.

Rare; Berwick.

8. *O. formosa* Bory. Lat. *formosus*, handsome.—Trichomes blue-green, associated into a membrane, not arcuate, elongate, often slightly constricted at the articulations, 4–6 μ broad; apices subobtus, shortly attenuate, hooked; articulations equal in length and breadth or $\frac{1}{2}$ as long as broad, calyptra absent; protoplasm sometimes slightly granular near dissepiments.

Rare; Berwick.

9. *O. brevis* Kütz. var. *neapolitana* Gom.—Filaments forming dense olive-green layers or intermixed with other species of algæ, fragile; trichomes 5–6.5 μ in diam.; apices uncinat or twisted; cells 3 times broader than long, with an occasional torulose cell interspersed.

Rare; Cumbræ.

10. *O. rosea* Batt. (*Oscillaria rosea* Crouan). Lat. *roseus*, pink.—Trichomes deep purple-red, 2–4 mm. long, 4–5 μ in diam., more or less bent and twisted, slightly curved at the apex; cells about as long as broad, apical cell sharply pointed.

On a polyzoan attached to a piece of broken bottle dredged from deep water, "Queen's Ground," Plymouth (Brebner).

Subfamily 3.—LYNGBYOIDEÆ

Trichomes simple or falsely branched; sheath firm or gelatinous; apices straight.

1. PHORMIDIUM Kütz.

(Gr. *phormidion*, a small rush mat.)

Trichomes many celled, single within a sheath, simple, frequently attenuate and uncinat at the apices; sheath distinct, hyaline, sometimes mucous, more or less diffuent. During the production of hormogonia, whole trichomes or smaller hormogonia may escape from the sheath, thus completely resembling the trichomes of *Oscillatoria*.

Key.

- | | |
|-------------------------------------------------------------|--------------------------|
| 1. Trichomes distinctly torulose | 3. |
| Trichomes rarely or scarcely torulose | 2. |
| 2. Trichomes less than 3 μ broad | <i>P. tenue</i> (2). |
| Trichomes 3 μ or more broad | 4. |
| 3. Trichomes rose-colour, apical cell round | <i>P. Ectocarpi</i> (8). |
| Trichomes brownish green, apical cell acutely conical | <i>P. fragile</i> (1). |

4. Apices of the trichomes straight, not capitate
Apices of the trichomes more or less curved,
capitate 5.
5. Apical cell obtusely conical 7.
Apical cell not or scarcely attenuate, truncate 6.
6. Filaments flexuose; trichomes 3-4.5 μ broad,
articulations about as long as broad or
rather longer *P. ambiguum* (5)
Filaments not flexuose; trichomes 3-5 μ
broad, articulations scarcely as long as
broad *P. corium* (3).
7. Aquatic; 6-9 μ broad, apices hooked or slightly
spiral *P. papyraceum* (4).
Terrestrial; 4-7 μ broad, apices rarely curved *P. uncinatum* (6).
..... *P. autumnale* (7).

1. **P. fragile** Gom.—Forming a thin yellowish or dark blue-green stratum, sometimes lamellate; trichomes more or less flexuose, moniliform, 1.2-2.3 μ in diam.; apices attenuate, acute, conical, calyptra absent; protoplasm homogeneous.

Rare; Wales and Northumberland.

2. **P. tenue** Gom. Lat. *tenuis*, slender.—Forming reddish olive, diffused strata; trichomes rather rigid, densely intricate, 1-1.5 μ broad, slightly curved; sheath inconspicuous, turning blue in chlor-zinc iodine; articulations distinct or indistinct, 1½ times as long as broad, contents homogeneous; apices somewhat bent, acute, conical, calyptra absent.

Rare; Berwick and Wales.

3. **P. corium** Gom. Lat. *corium*, skin.—Stratum toughly membranaceous, compact, brown, steel-blue or greenish, interwoven; trichomes more or less flexuose, rather rigid, olive or brown, then yellowish; articulations 3-4.5 μ broad, 1 or 1½ times longer than broad; protoplast granular; apex conically attenuate, not capitate, calyptra absent.

Not uncommon.

4. **P. papyraceum** Gom. (*Oscillatoria spiralis* Carm.). Lat. *papyraceus*, papery.—Stratum firm, coriaceous, glossy black; trichomes radiating, 3-5 μ broad, flexuose, twisted into spirals; articulations distinct, 2-4 μ long; protoplast granular; apical cell obtusely conical, calyptra absent.

Not uncommon.

5. **P. ambiguum** Gom.—Stratum dark or yellowish green, at times æruginous; filaments long and flexuose; sheath either firm or mucous and diffuent, somewhat thick and lamellate; trichomes slightly constricted at the dissepiments, 4-6 μ in diam.; articulations ¼ as long as broad, occasionally granular at the cross-walls; apices neither attenuate nor capitate, terminal membrane slightly thickened.

Cumbræ.

6. **P. uncinatum** Gom. Lat. *uncinatus*, barbed.—Stratum radiating, green, mucilaginous, trichomes rigid, straight except at the apices, æruginous or olive-brown; articulations equal in

length and breadth or 2-3 times broader than long, frequently granular, $6-9\mu$ in diam.; apices obtuse, curved or somewhat spiral, calyptra rounded or conical.

Berwick.

7. *P. autumnale* Gom.—Stratum thin, more or less expanded, mucilaginous, dark coloured, becoming thickened with age, but rarely lamellate; trichomes straight, rigid, sheath distinct; articulations equal to their diameter, or shorter; protoplast

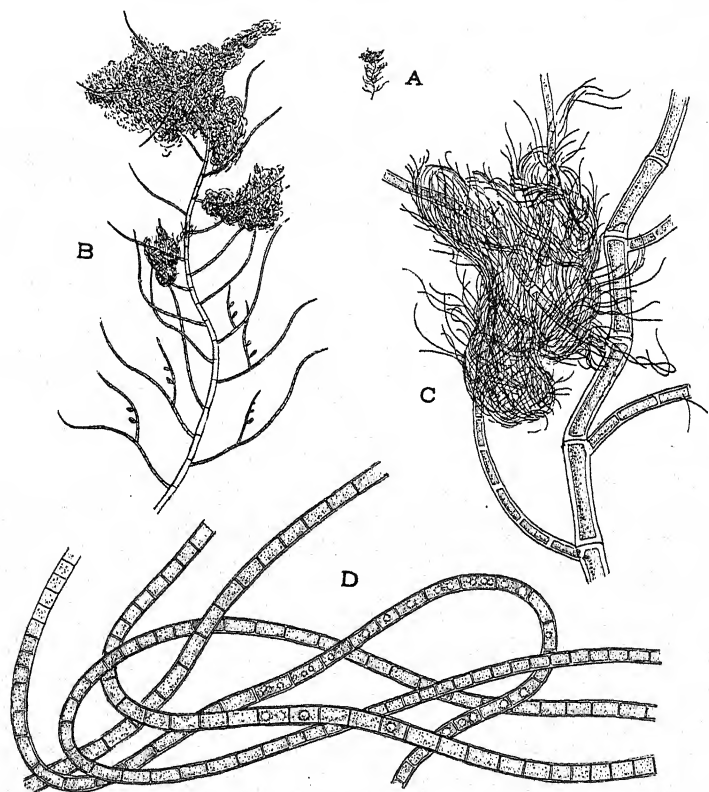


Fig. 15.—*Phormidium corium* Gom. A. Colony on host ($\times 3$); B. ($\times 12$); C. ($\times 60$); D. ($\times 600$).

granular, $4-7\mu$ broad; apices attenuate, more or less curved, calyptra rounded, sometimes bearded.

Not uncommon.

8. *P. Ectocarpi* Gom. (*P. persicinum* Batt., non Gom.). *Ectocarpus*, a genus of algæ.—Stratum thin, rose-coloured; trichomes delicate, erect, tightly intertwined or parallel in

arrangement; sheath often inconspicuous, turning blue in chlorine iodine; trichomes pale rose-colour, moniliform; apices rarely slightly attenuate, usually rounded, $1.3-2\mu$ broad, articulations equal in length and breadth, or slightly longer than broad, calyptra absent.

Rare; Cumbrae and Plymouth.

2. *SYMPLOCA* Kütz.

(Gr. *sun*, with, and *plokos*, a lock of hair.)

Filaments loosely attached at the base, forming prostrate or erect, pointed tufts; trichomes single within a sheath, sparingly falsely branched, straight at the apices, branches solitary; sheaths thin, hyaline, firm or slightly mucous. May usually be recognised by its occurring in more or less extended layers, with the filaments at first prostrate, later forming erect tooth-like tufts.

Key.

- | | |
|---------------------------------------------------------------------------------------|-----------------------|
| Dark blackish steel colour; trichomes $6-14\mu$ broad, apices somewhat torulose | <i>S. hydnoides</i> |
| Dark green or purplish; trichomes $4-6.5\mu$ broad, torulose throughout | <i>S. atlantica</i> . |

S. hydnoides Kütz. (*Calothrix semiplena* Harv., *S. Harveyi* Le Jol.). *Hydnum*, a genus of fungi, *eidos*, like.—Filaments

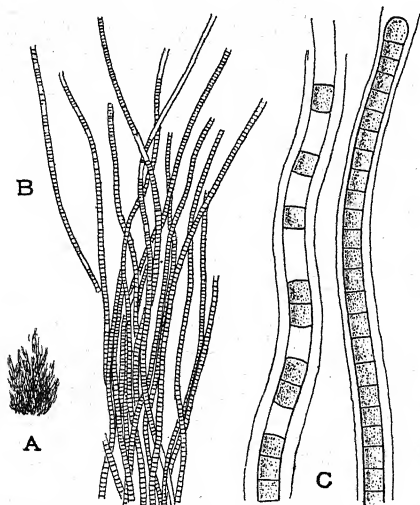


Fig. 16.—*Symploca hydnoides* Kütz. A. Colony ($\times \frac{2}{3}$); B. ($\times 100$); C. ($\times 430$).

forming tooth-like fascicles, dark steel-colour, 1–2 cm. high, sparingly falsely branched; sheaths thin, slightly mucous;

trichomes blue-green, $6-8\mu$ broad, slightly torulose near the apex; length of cells variable, $5-14\mu$ long; protoplasm filled with granules, particularly near the cross-walls; apical cell slightly inflated, without calyptra.

Widely distributed.

var. *fasciculata* Gom. (*S. fasciculata* Kütz.).—Trichomes $8-14\mu$ broad; articulations $\frac{1}{2}$ as broad as long or equal in length and breadth. Not uncommon; widely distributed.

S. atlantica Gom.—Colonies dark blue-green, erect, as much as 1 cm. in height; filaments densely entangled, free, simple, angular; trichomes $4-6\mu$ broad, torulose throughout, articulations $\frac{1}{4}-\frac{1}{2}$ as long as broad; sheath conspicuous, clear, colourless, apical cell sunk in calyptra.

Rare; Wales and Studland.

var. *purpurea* Batt.—Erect filaments $800\mu-1$ mm. long, $6-5\mu$ broad, clear purplish red. Devon.

3. LYNGBYA C. A. Agardh

(After H. C. Lyngbye, Danish algologist.)

Trichomes with a sheath, simple, either free or aggregated into dense, floccose, cæspitose masses, attached or free-floating; sheath thin and homogeneous or thick and lamellate, hyaline or dull yellowish brown; trichomes not constricted at the dissepiments, not attenuate at the apices or only slightly so, terminal wall often thickened.

Key.

- | | |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Trichomes fixed at the centre, free at both extremities; sheath thin, hyaline; epiphytic | 2. |
| Trichomes free or with an attached base; sheath often broad and lamellate | 3. |
| 2. Violet coloured; filaments short, straight..... | <i>L. Agardhii</i> (1). |
| Tufted, dark blue-green, gelatinous | <i>L. Meneghiniana</i> (2). |
| 3. Trichomes $0.7-0.8\mu$ broad, growing in the gelatinous sheaths of other algæ | <i>L. Rivulariarum</i> (7). |
| Trichomes broader | 4. |
| 4. Sheath not turning blue with chlor-zinc iodine; articulations very short | 5. |
| Sheath turning blue with chlor-zinc iodine; articulations equal in length and breadth, or $\frac{1}{2}$ as long as broad | <i>L. lutea</i> (6). |
| 5. Sheath dark yellowish-brown | <i>L. cæstuarii</i> (3). |
| Sheath often colourless | 6. |
| 6. Trichomes $16-60\mu$ broad; protoplast not granular | <i>L. majuscula</i> (4). |
| Trichomes $5-12\mu$ broad; protoplast granular, particularly near the cross-walls | <i>L. semiplena</i> (5). |

Subgenus *Leibleinia* Gom.

Filaments cæspitose, fixed when submerged, epiphytic, attached by the central portion and intertwined, erect at

both ends; sheaths thin, hyaline, not clearly laminate; trichomes not attenuate at the apices.

1. **L. Agardhii** Gom. After C. A. Agardh, Swedish algologist.—Trichomes purple or greyish violet, 5–10 mm. long, straight at the extremities, fixed in the middle; sheath thin, not turning blue with chlor-zinc iodine, torulose; apices not attenuate, 8–8.5 μ in diam.; articulations 3–4 times as broad as long, rarely equal in length and breadth; protoplast granular; apical cell rounded, calyptra absent.

Rare; Kent and Devon.

2. **L. Meneghiniana** Gom. After J. Meneghini, Italian algologist.—Trichomes caespitose, mucous, dark blue-green, as much as 1 cm. in height; filaments erect, very flexuose; sheath inconspicuous, not turning blue with chlor-zinc iodine; apices not attenuate; trichomes 6.5–8 μ broad, articulations 2–4 times as broad as long, apical cell rounded.

Rare; S. Scotland.

Subgenus *Eulyngbya* Gom.

Filaments intertwined into a floccose or woolly expanded mass, or tufted with an attached base, or even free-floating; sheaths often thick and lamellate as they become older, at times yellowish brown; trichomes sometimes attenuate at the apices. Occurring on rocks; rarely epiphytic.

3. **L. æstuarii** Liebm. (*L. ferruginea* C. A. Agardh).—Forming dense floating masses of dark or ferruginous colour; sheaths thick, lamellate, deep yellowish brown, not turning blue with chlor-zinc iodine; articulations 3–6 times as broad as long; protoplast frequently granulate; trichomes 10–16 μ or more in breadth, apices slightly attenuate, capitate, with slightly thickened end wall, rarely sub-acute, conical.

Not uncommon.

var. **limicola** Gom.—Filaments closely interwoven, very tortuous.

var. **natans** Gom.—Filaments elongated, flexuose or nearly straight and loosely intertwined. Flintshire.

var. **symplocoidea** Gom.—Filaments prostrate at the base, erect and tufted above. Flintshire.

var. **ferruginea** Gom. Dark, sheaths thick, lamellate, deep yellowish brown. Not uncommon.

var. **æruginea** Gom. Pale blue-green, sheaths moderately thin, hyaline. Flintshire.

var. **spectabilis** Gom. (*L. spectabilis* Thur.).—Sheaths up to 14 μ thick, hyaline on exterior, changing to yellowish within. Flintshire.

4. **L. majuscula** Harv. Lat. *majusculus*, somewhat greater.—Filaments widely spreading, blackish-green, forming a tuft

several inches in diam., lying flat on the surface of rocks or floating; trichomes tortuous, simple or occasionally cohering together as if branched, $16-60\mu$ broad; articulations 6-15 times broader than long; sheath broad and colourless; protoplast not granular; apical cell round, calyptra absent.

Not uncommon; widely distributed.

5. *L. semiplena* J. G. Agardh. Lat. *semi*, half, *plenus*, full.—In tufts, rarely more than 3 cm. high, dull blue-green, darker when dry; trichomes interwoven; filaments decumbent at the base, flexuose above; sheath hyaline, somewhat mucilaginous, sometimes distinctly lamellate, as much as 3μ broad, not turning blue with chlor-zinc iodine; trichomes blue-green, apices slightly attenuate, capitate, not constricted, $5-12\mu$ broad, cells

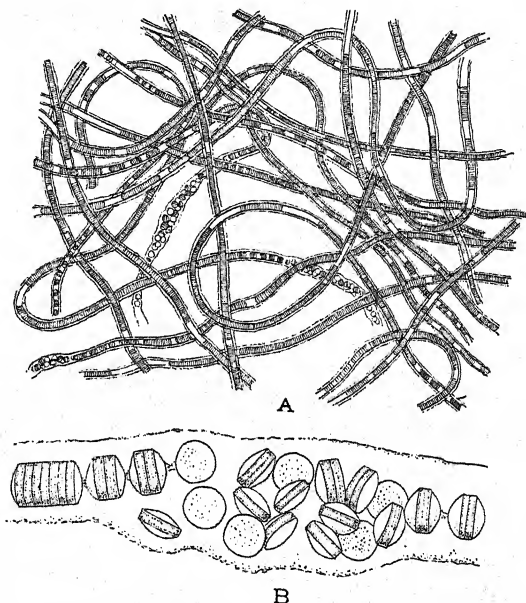


FIG. 17.—*Lyngbya aestuarii* Liebm. A. Colony ($\times 60$) B. Hormogonia ($\times 300$).

$2-3\mu$ long; protoplast granular, particularly near the cross-walls; apical cell with conical or rounded calyptra.

Not uncommon.

6. *L. lutea* Gom. Lat. *luteus*, golden yellow.—Forming a somewhat gelatinous coriaceous tuft, blackish green, dull violet or steel-colour, more or less radiating; trichomes olive-green, not constricted; apices not attenuate, $2.5-6\mu$ broad, somewhat flexuose; sheath hyaline, turning blue with chlor-zinc iodine, about 3μ broad, lamellate; articulations equal in length and

breadth, or 2-3 times broader than long; protoplast granular; apical cell with rounded calyptra.

Occurring where fresh water runs into the sea. Rare; Wales and Scotland.

7. **L. Rivulariarum** Gom. *Rivularia*, a genus of algæ.—Filaments very thin, twisted; sheath hyaline, thin; trichomes pale blue-green, 0.7-0.8 μ broad, constricted at intervals, apices not attenuate, articulations 4 times as long as broad; protoplast not granular; apical cell rounded, calyptra absent.

Within the sheaths of *Microcoleus chthonoplastes*. Rare; Dorset and Cumbræ.

4. PLECTONEMA Thur.

(Gr. *plektos*, interwoven, and *nema*, a thread.)

Trichomes in sheaths, with false branching, caused by the rapid division of parts of the filaments, rupturing the sheaths; frequently constricted at the articulations; apices sometimes slightly attenuate, without calyptra; sheaths hyaline or rarely coloured.

Key.

- | | |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1. Forming a gelatinous layer on rocks | 2. |
| Not saxicolous | 3. |
| 2. Trichomes 1.5-2 μ broad; articulations twice as broad as long; apical cell rounded | <i>P. norvegicum</i> (4). |
| Trichomes 2-3.5 μ broad; articulations up to 4 times as broad as long; apices gradually tapering, elongated | <i>P. Battersii</i> (3). |
| 3. Within the gelatinous sheaths of various algæ | <i>P. Nostocorum</i> (1). |
| Within the chalky shells of molluscs | <i>P. terebrans</i> (2). |

1. **P. Nostocorum** Born. *Nostoc*, a genus of algæ.—Filaments falsely branched; sheath hyaline, cylindrical, not turning blue with chlor-zinc iodine; trichomes pale blue-green, 1-1.5 μ broad; articulations about 1½ or twice as long as broad; protoplast not granular; apical cell rounded.

Within the sheaths of *Rivularia bullata*, *Schizothrix vaginata*, and *Dichothrix gypsumphila*. Rare; widely distributed.

2. **P. terebrans** Born. & Flah. Lat. *terebrans*, boring.—Filaments elongated, flexuose, sparingly falsely branched; sheath hyaline, thin, cylindrical, not turning blue with chlor-zinc iodine; trichomes pale blue-green, not torulose, 0.95-1.5 μ broad, articulations 2-6 μ long; protoplast with two granular bodies near the cross-walls; apical cell rounded.

Within the calcareous shells of several species of molluscs. Not uncommon.

3. **P. Battersii** Gom. After E. A. L. Batters, British algologist.—Filaments forming a black or dark green stratum, elongate, flexuose, abundantly and repeatedly falsely branched; branches usually in pairs and smaller than the primary filaments;

trichomes torulose, pale blue-green, $2-3.5\mu$ broad, with long and gradually attenuate apices; older trichomes often densely contorted within the sheath; cells with homogeneous contents, as much as four times as broad as long; apical cell rounded.

On rocks near high-water mark. Probably not uncommon; Berwick.

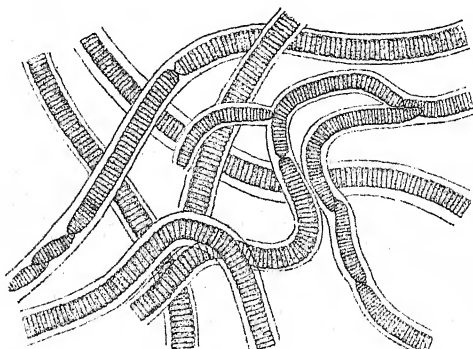


Fig. 18.—*Plectonema Battersii* Gom. ($\times 300$.)

4. *P. norvegicum* Gom.—Forming an encrusting layer, dark blue-green; filaments elongate, tortuose, abundantly falsely branched; branches patent, short, equal in diameter to the main filament; sheath not attenuate, hyaline, pale brown, not turning blue with chlor-zinc iodine; trichomes pale blue-green, torulose, submoniliform, $1.5-2\mu$ broad; articulations twice as broad as long, apical cell rounded.

Probably not uncommon; Essex and Dorset.

Family II.—VAGINARIACEÆ

Trichomes in well-developed filaments, two to many within a common sheath; sheaths often coloured, yellowish brown, red or blue.

1. *MICROCOLEUS* Desm.

(Gr. *mikros*, small, and *koleos*, a sheath.)

Trichomes numerous, within a common, firm, hyaline, cylindrical sheath, unbranched, tapering at each extremity; filaments densely intertwined, forming more or less diffuent masses; apices of trichomes straight, attenuate, tightly interwoven within the sheath; apical cells acute or rarely obtuse, conical or capitate. Differing from *Hydrocoleum* in the larger number of trichomes in a sheath and their smaller size.

Key.

Trichomes $2.5-6\mu$ thick	.....	<i>M. chthonoplastes</i> .
Trichomes $1.5-2\mu$ thick	.....	<i>M. tenerrimus</i> .

1. *M. chthonoplastes* Thur. (*M. anguiformis* Harv.). Gr. *chthonoplastos*, formed of earth.—Filaments forming a thick dark olive-green coriaceous layer on damp mud, or mingled with other algæ; sheaths cylindrical, tapering at both extremities, completely closed or open with projecting trichomes; trichomes blue-green, short, nearly straight, numerous, closely packed,

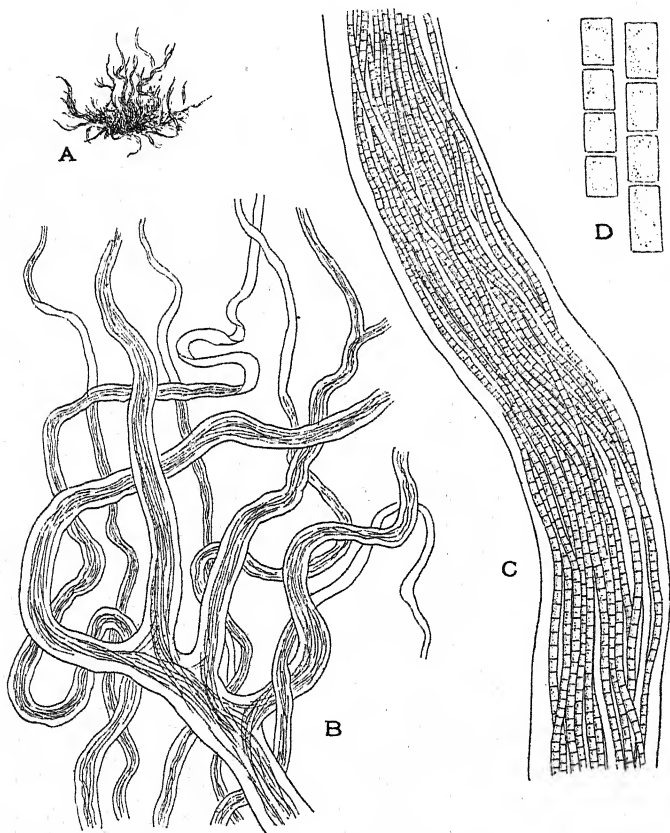


Fig. 19.—*Microcoleus chthonoplastes* Thur. A. Colony ($\times 30$); B. ($\times 30$); C. ($\times 300$); D. Cells ($\times 1200$).

constricted at intervals; cells $2.5-6\mu$ broad, $3.6-10\mu$ long; apices of trichomes attenuate, acute, conical.

Not uncommon; widely distributed.

2. *M. tenerrimus* Gom. Lat. *tenerrimus*, very delicate.—Forming dense blue-green layers, or growing among other algæ, simple or sparsely branched; sheaths irregular, apices acuminate or open and obtuse; trichomes dark olive-green, elongate,

flexuose, loosely intertwined, markedly constricted at intervals, 1.5–2 μ thick, with occasional granules at the cross-walls, apices sharply pointed; apical cell acute, conical, not capitate.

On rocks near high-water mark; Torquay.

Easily distinguished from *M. chthonoplastes* by the slender sharply pointed trichomes, and by the smaller number of them in each sheath.

2. HYDROCOLEUM Kütz.

(Gr. *hudor*, water, and *koleos*, a sheath.)

Forming a smooth or cæspitose cushion, at times lime encrusted; sheaths hyaline, cylindrical, sublamellate, sparingly

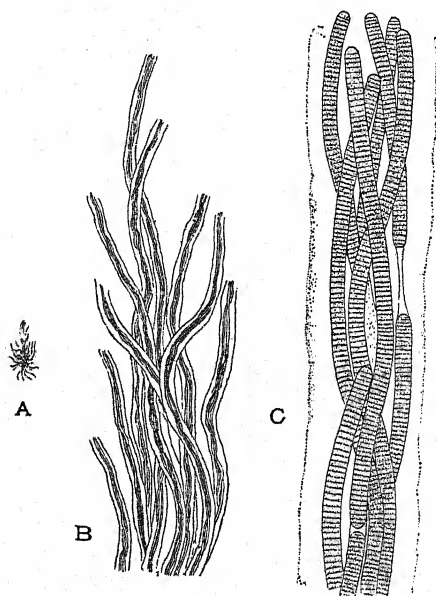


Fig. 20.—*Hydrocoleum lyngbyaceum* Kütz. A. Colony ($\times \frac{2}{3}$); B. ($\times 60$); C. ($\times 300$).

falsely branched, more or less mucous, at times completely diffluent; trichomes few, loosely aggregate into a sheath; apices straight, more or less attenuate and capitate.

Key.

Trichomes 9–11 μ broad	<i>H. lyngbyaceum</i> .
Trichomes 17–19 μ broad	<i>H. glutinosum</i> .

H. lynghyaceum Kütz. *Lynghya*, a genus of algæ.—Forming tufts, usually epiphytic; filaments unbranched below, falsely branched above; sheath firm, broad, apices acuminate, sometimes diffluent; trichomes dark blue-green, numerous at the base of the filaments, often solitary in the branches, sometimes spirally twisted, 8–16 μ broad, somewhat attenuate and truncate at the apices; cells 2.5–4.5 μ long, protoplast granular near the cross-walls.

Rare; widely distributed.

var. **rupestre** Kütz. (*Microcoleus nigrescens* Thur.)—Sheath entirely diffluent. Rare; Berwick and Kent.

H. glutinosum Gom. (*Oscillaria percursa* Kütz. var. *marina* Kütz.)—Filaments slender, flaccid, interwoven into a fleecy blackish green or brownish yellow stratum; sheath distinct, irregular; trichomes not constricted, 14–21 μ broad, cells 2.5–3.5 μ long; protoplast granular near the cross-walls; apices attenuate, truncate.

On the muddy bottoms of shallow pools near high-water mark. Rare; Berwick.

3. SCHIZOTHRIX Kütz.

(Gr. *schizo*, to split, and *thrix*, a hair.)

Usually more than one trichome in a sheath; filaments in small groups or forming a gelatinous cushion; sheath usually thick, sometimes thin, colourless, yellow, brownish red or rarely violet or blue; usually closed at the apex, very much attenuate.

Key.

- | | |
|---------------------------------------------------------------------------------------------|----------------------------|
| 1. Sheath colourless; cells equal in length and breadth or a little longer than broad | <i>S. lardacea</i> (2). |
| Sheath coloured; cells usually shorter than their breadth | 2. |
| 2. Filaments collected into rope-like bundles, yellowish or greenish-olive | <i>S. Cresswellii</i> (1). |
| Filaments in parallel rows or grouped together, brownish or almost black | <i>S. vaginata</i> (3). |

1. **S. Cresswellii** Harv. After the Rev. R. Cresswell, British diatomist.—Forming dense, soft, pulvinate, convex tufts, 2.5–5 cm. in diam., somewhat mucilaginous, composed of slender yellowish or greenish olive translucent filaments, collected into rope-like bundles; trichomes about 6 μ broad at the base, 2 μ at the apex.

Very rare; Devon.

2. **S. lardacea** Gom. Lat. *lardaceus*, having the appearance of lard.—Filaments adhering closely to the substratum, forming a laminate layer as much as 3 cm. thick, dark green or reddish; filaments elongate, twisted, sparingly branched; sheath colourless and attenuate, at first thin, later thick and irregular, turning

blue in chlor-zinc iodine, containing few trichomes; cells not moniliform, but often granular at the cross-walls, $1.5-2\mu$ broad, equal in length and breadth or a little longer than broad, $2-3\mu$ long; end cell rounded.

On stones. Rare; Devon.

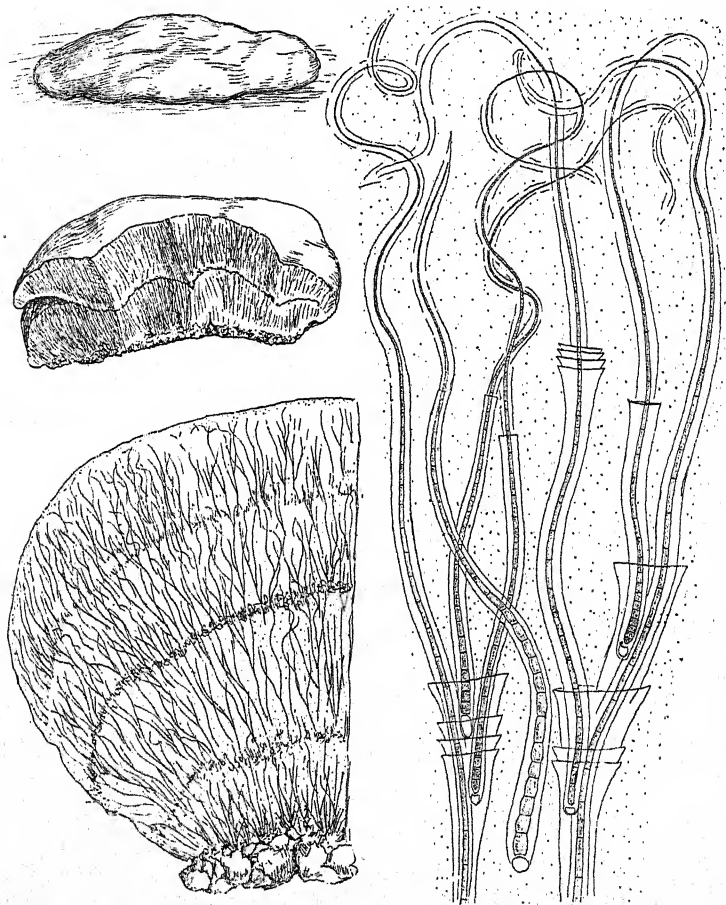


Fig. 21.—*Schizothrix vaginata* Gom. A. Colony ($\times \frac{2}{3}$); B. ($\times 8$); C. ($\times 50$); D. ($\times 300$).

3. *S. vaginata* Gom. Lat. *vagina*, a sheath.—Forming a brownish or almost black encrusting layer; filaments straight, in parallel rows or grouped together, branched; sheath thick, often stratified, attenuate at the tip, turning blue with chlor-zinc iodine, containing few trichomes; cells with granules near the

cross-walls, not moniliform, $2-3\mu$ broad, usually shorter than their breadth; end cell rounded.

Forming a gelatinous layer on stones or on other algæ. Devon and Scotland.

Suborder II.—*HETEROCYSTINEÆ*

Filaments usually attached, at least at first, but some free-floating; trichomes composed of cells differing from one another either through the presence of heterocysts, trichomes ending in a hair, or both; simple or branched; branching true or false; sheath usually present, enclosing one or more trichomes, hyaline or coloured, homogeneous or stratified. Propagation chiefly by hormogonia; resting spores present in some species.

Family I.—*RIVULARIACEÆ*

Filaments forming more or less spherical or hemispherical colonies, radiating outwards from the centre, parallel, or rarely solitary; cohering by their gelatinous sheaths, simple or branched; single cell series in each sheath; trichomes usually much attenuate, terminating in a hair, one or more within each sheath; heterocysts basal and intercalary, rarely absent; branching false, usually beneath the heterocysts. Propagation by hormogonia, resting spores or both.

1. *AMPHITHRIX* Born. & Flah.

(Gr. *amphi*, round about, and *thrix*, a hair.)

Thallus encrusting or tufted, dark purplish, consisting of a horizontal layer formed of interwoven filaments, or trichomes in

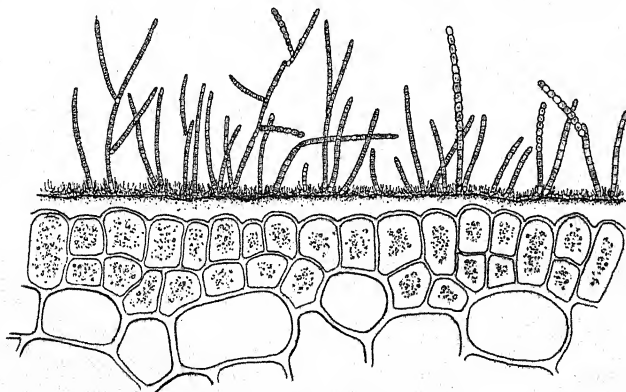


Fig. 22.—*Amphithrix Laminariæ* Kuckuck. Colony on host: Long. sect. ($\times 600$).

radial rows more or less interlaced, and a layer of erect simple filaments attenuate here and there into a long hair; sheath thin. Hormogonia solitary or in chains.

A. violacea Born. & Flah.—Thallus in dark red or violet tufts; filaments fasciculate, 1–3 mm. high, 2–3 μ broad; sheath thin, uniform; trichomes granular, subtorulose.

Scotland.

2. CALOTHRIX C. A. Agardh

(Gr. *kalos*, beautiful, and *thrix*, a hair.)

Filaments simple or with false branching; sheaths cylindrical, usually aggregated into masses; trichomes attenuate, often ending in hyaline hairs; heterocysts intercalary or basal, single or several in a series. Spores observed in some species.

Key.

- | | |
|----------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Heterocysts basal | 2. |
| Heterocysts basal and intercalary | 7. |
| 2. Trichomes gregarious, fasciculate or penicilliate; epiphytic | 3. |
| Trichomes caespitose; often saxicolous | 4. |
| 3. Filaments 12–15 μ broad; trichomes steel-blue, violet or purple; sheath often hyaline | <i>C. confervicola</i> (1). |
| Filaments 21–29 μ broad; trichomes olive-green; sheath muddy brown | <i>C. consociata</i> (2). |
| 4. Trichomes olive-green | 5. |
| Trichomes blue-green; plants parasitic | 6. |
| 5. Filaments 10–18 μ broad, quivering, loosely caespitose, free | <i>C. scopulorum</i> (3). |
| Filaments 9–15 μ broad, somewhat flexuose, in dense encrusting strata | <i>C. Contarenii</i> (4). |
| Filaments 15–20 μ broad, fasciculate, in spongy hairy stratum | <i>C. pulvinata</i> (5). |
| 6. Immersed in the thallus of other algæ, base of the filament swollen | <i>C. parasitica</i> (6). |
| Base of the filament scarcely swollen, free | <i>C. æruginea</i> (7). |
| 7. Filaments simple | 8. |
| Filaments branched | 9. |
| 8. Filaments 9–10 μ broad, sheath often hyaline ... | <i>C. æruginea</i> (7). |
| Filaments 12–40 μ broad, sheath muddy brown | <i>C. crustacea</i> (8). |
| 9. False branches clustered near the apex of the filaments | <i>C. fasciculata</i> (10). |
| False branches occurring in pairs between the heterocysts, filaments decumbent | <i>C. vivipara</i> (9). |

1. **C. confervicola** C. A. Agardh. *Conferva*, a genus of algæ; Lat. *colo*, I inhabit.—Tufts fasciculate; filaments short, 12–15 μ broad, glaucous, opaque, blunt, rigid, straight or slightly curved; free, or united at the base, unbranched; heterocysts basal, few; trichomes steel-blue, violet or purple; sheath often hyaline.

On small algæ, between the tide-marks. Common.

var. **purpurea** Born. & Flah. Trichomes purple. Rare; Norfolk and Sussex.

2. **C. consociata** Born. & Flah. Lat. *consociatus*, united.—Filaments gregarious, dark blackish green, rigid, basal portion curved round and procumbent; trichomes 0.5 mm. high, 21–29 μ broad; sheath compressed, brownish, membranaceous, extending beyond the apex of the filament, lamellate, exterior often hyaline; cells 12 μ broad, olive-green, 3 times as broad as long; heterocysts basal.

On *Chcetomorpha* and other filamentous algæ. Rare; Norfolk.

3. **C. scopulorum** C. A. Agardh. Lat. *scopulus*, a rock.—Filaments contorted, erect, as much as 1 mm. in height, 10–18 μ broad, somewhat thickened at the base, forming a caespitose expanded olive-green stratum; sheaths thick, hyaline, yellowish brown or zoned; trichomes olive-green, 8–15 μ broad, attenuate at the apex into a hyaline hair; heterocysts 1–3, basal. Hormogonia numerous in a sheath, 4–5 times as long as broad.

Forming slimy patches on surface of rocks near high-water mark. Not uncommon; widely distributed.

4. **C. Contarenii** Born. & Flah. After N. Contarini, Venetian naturalist.—Forming a blackish green, smooth, shining stratum; filaments parallel, erect, more or less flexuous, as much as 1 mm. high, 9–15 μ broad, decumbent and thickened near the base; sheaths thick, hyaline or yellowish brown, lamellate or homogeneous, swollen near the top; trichomes 6–8 μ broad, attenuate at the apices into a long hair; cells as long as broad or 2 or 3 times shorter; heterocysts basal, 1 or 2 present.

On rocks near high-water mark. Rare; Dorset.

5. **C. pulvinata** C. A. Agardh. (*C. hydroides* Harv., *C. pan-nosa* Harv.). Lat. *pulvinatus*, cushion-shaped.—Filaments erect, flexuose, united into small irregular tufts, 2–3 mm. high, 15–20 μ broad, slightly enlarged at the base, forming spongy expanding layers; sheaths thick, firm, lamellate, hyaline or brownish; trichomes sparingly falsely branched, 8–12 μ broad, olive-green, attenuate into a short hair; heterocysts basal, cells 2–3 times broader than long.

On rocks, *Pelvetia canaliculata* and other algæ near high-water mark. Not uncommon.

6. **C. parasitica** Thur.—Filaments deep blue-green, 0.5 mm. high, 9–10 μ or more in diam., slightly thickened in the centre, swollen and curved at the base, as much as 24 μ thick; sheath thin, hyaline, often swollen at the apex; trichomes 7–8 μ broad; cells short, attenuate upwards into a long flexuose hyaline hair; heterocysts basal. Several hormogonia in a sheath, 4–5 times as long as broad.

Growing in the fronds of other algæ, particularly *Nemalion multifidum*. Rare; Dorset and Cornwall.

7. **C. æruginea** Thur. Lat. *ærugineus*, verdigris-colour.—Filaments bright emerald-green, 0.5 mm. high, 9–10 or rarely

12μ broad, attached at the base; sheath relatively thick, often hyaline, rarely yellowish at the base, uniform in thickness; trichomes $7-9\mu$ broad, attenuate into a long hair; heterocysts basal, 1 or 2 present, or occasionally intercalary or absent.

Rare; widely distributed.

Often mixed with *Calothrix confervicola*, from which it can be distinguished by its bright colour and small size.

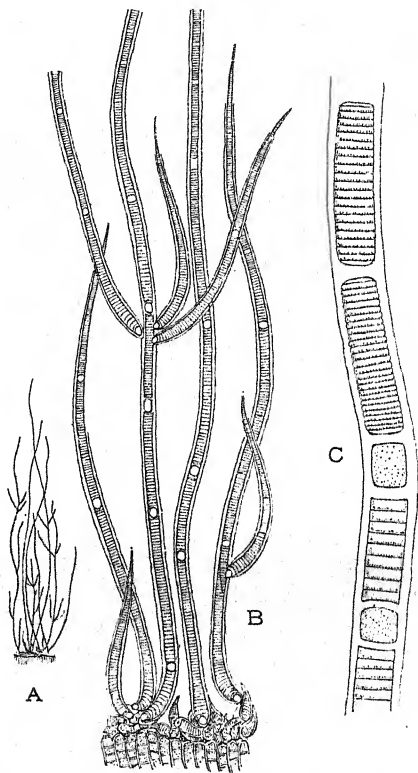


Fig. 23.—*Calothrix crustacea* Thur. A. ($\times 12$); B. ($\times 100$); C. showing heterocysts ($\times 300$).

8. *C. crustacea* Thur.—Filaments caespitose or velvety, dark green or brownish, erect, straight, closely packed, 1–2 mm. high, $12-20\mu$ or more in diam., thickened at the base; sheaths thick, hyaline or yellowish brown, mostly lamellate; trichomes olive-green, $8-15\mu$ broad, attenuate at the apex, ending in a hair; cells short; heterocysts basal and intercalary. Hormogonia numerous in a sheath, 4–5 times longer than the diam.; spores seriate, oblong-cylindrical, smooth.

On rocks and algæ between the tide marks. Not uncommon; widely distributed.

Distinguished from *Calothrix confervicola* by its numerous intercalary heterocysts.

9. *C. vivipara* Harv. Lat. *viviparus*, producing young alive. —Filaments decumbent and entwined at the base, becoming erect and parallel, 3–5 mm. high, 12–24 μ broad, somewhat flexuose; pseudo-branches numerous, often in pairs; sheaths thick, somewhat mucous, homogeneous, hyaline or yellowish brown; trichomes olive-green, 9–15 μ broad, attenuate at the apices, prolonged into a hair; length of cells equal to breadth or shorter; heterocysts basal or intercalary, 2–4 seriate.

Forming velvety coating on rocks. Arbroath.

10. *C. fasciculata* C. A. Agardh. Lat. *fasciculatus*, clustered. —Stratum indefinite, velvety, dark green; trichomes tufted, erect, straight, attenuate at the apices, ending in a hair; simple when young, later clothed with fascicles of pseudo-branches attached a little above the middle of the filament; heterocysts numerous, intercalary.

Spreading over the surface of rocks near high-water mark. Rather rare; widely distributed.

Distinguished from *Calothrix scopulorum* by the groups of pseudo-branches and numerous intercalary heterocysts.

3. *DICHOTHRIX* Zanard.

(Gr. *dicha*, in two, and *thrix*, a hair.)

Filaments subdichotomously branched; 2–6 trichomes in a common sheath; heterocysts basal or intercalary or absent.

D. gypsophila Born. & Flah. Gr. *gypsos*, chalk, *philos*, loving. —Brown or almost black, smooth, in small tufts or strata, on rocks near high-tide mark; trichomes about 0.6 mm. long, 12–14 μ broad, subdichotomously branched, somewhat attenuate at the ends; sheath rather close, brownish yellow; articulations equal in length and breadth or twice as broad as long; heterocysts the size of the trichome, usually 2 or 3 in a series.

On rocks near high-water mark. Dorset and Devon.

4. *ISACTIS* Thur.

(Gr. *isos*, like, and *aktis*, a beam.)

Filaments more or less parallel, erect, densely crowded and coalescent into a compact layer attached to the substratum, simple or sparsely branched; heterocysts basal. Reproduction by spores unknown. Differing from *Rivularia* in its more simple trichomes, which are crowded and more or less parallel.

I. plana Thur. (*Rivularia plana* Harv.). Lat. *planus*, flat. —

Fronds 0.5 mm. thick or less, spread out indefinitely on the surface of rock, or growing on other algæ, dark green; filaments

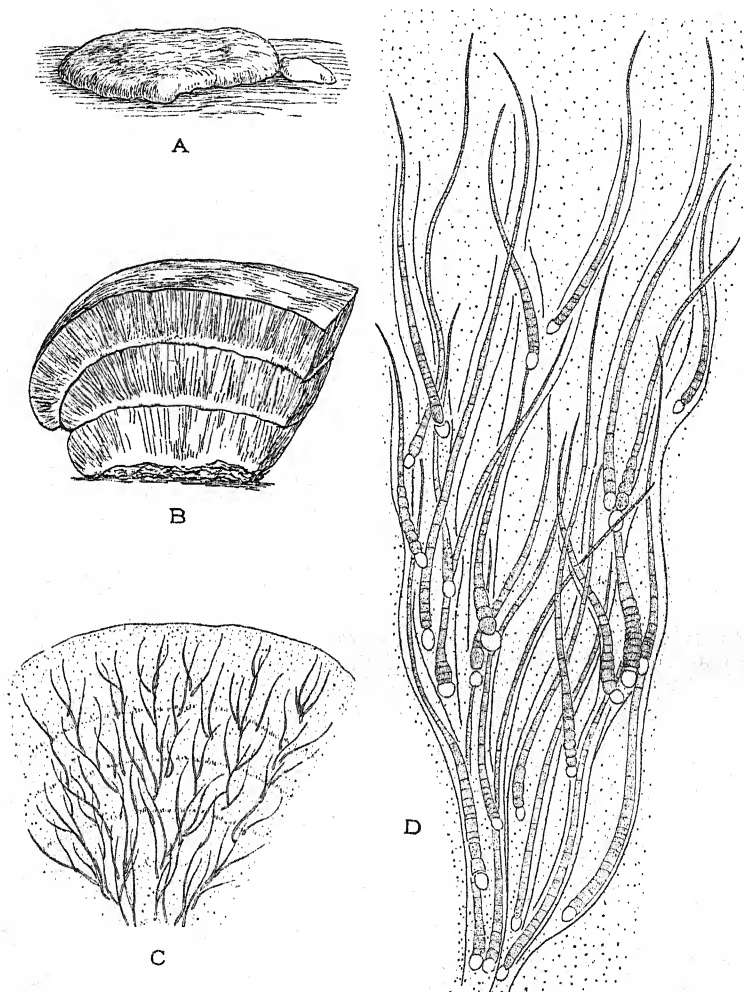


Fig. 24.—*Dichothrix gypsophila* Born. & Flah. A. Colony ($\times \frac{3}{2}$); B. ($\times 8$); C. ($\times 48$); D. ($\times 300$).

densely crowded, mostly simple; trichomes 7-9 μ broad, light blue-green, attenuate, ending in a hair when young.
Not uncommon; widely distributed.

var. *fissurata* Born. & Flah. Distinguished from *Rivularia atra* var. *confluens*, by the filaments of which the frond is com-

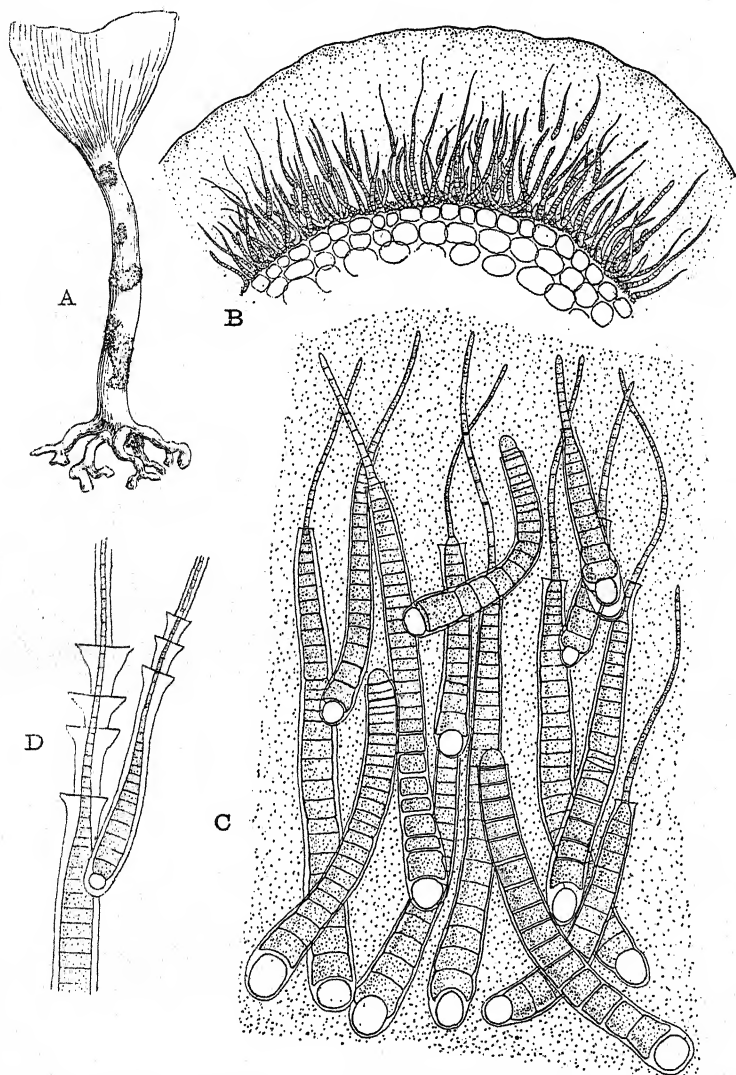


Fig. 25.—*Isactis plana* Thur. A. Colonies on host ($\times 3$); B. Long. sect. ($\times 120$); C. ($\times 600$); D. Apices of trichomes with sheaths ($\times 600$).

posed being more or less parallel, and not radiating from the base. Berwick.

5. RIVULARIA C. A. Agardh

(Lat. *rivulus*, a small brook.)

Thallus hemispherical, lobed or globose, solid, hollow, or confluent into an expanded stratum; filaments radiating from the centre or from the base, repeatedly falsely branched; heterocysts basal. Cylindrical spores produced in some species near the heterocyst.

Key.

- | | |
|----------------------------------------------------------------------------------------------|-----------------------------|
| 1. Thallus solid | 2. |
| Thallus hollow | 3. |
| 2. Filaments readily separating from one another under pressure | <i>R. Biasoletiana</i> (1). |
| Filaments not separating easily | <i>R. atra</i> (2). |
| 3. Thallus firm, sheath scarcely visible, not separating easily under pressure | 4. |
| Thallus soft, filaments separating readily under pressure; trichomes 5-7.5 μ broad | <i>R. australis</i> (6). |
| 4. Filaments olive-green, 2-5 μ broad | <i>R. nitida</i> (3). |
| Filaments muddy green, 5-10 μ broad | <i>R. bullata</i> (4). |
| Filaments dark green, 7-12 μ broad | <i>R. mesenterica</i> (5). |

1. **R. Biasoletiana** Menegh. (*Schizosiphon Warreniæ* Casp.) After B. Biasoletto, Italian naturalist.—Thallus gelatinous, hemispherical when young, later becoming broadly expanded and diffuent, cushion-shaped, often lime encrusted, dark olive-green, becoming yellow or brownish on the surface; filaments densely packed, 18 μ in diam.; sheath well developed, lamellate or zonate, hyaline or yellowish; trichomes 5-9 μ broad, attenuate into a delicate flexuose hair; cells near base slightly shorter than broad, $\frac{1}{3}$ the diam. above; heterocysts oblong, basal, 1-3 seriate, or rarely intercalary.

On rocks at high-water mark. Not uncommon; widely distributed.

2. **R. atra** Roth. Lat. *ater*, black.—Thallus blackish green, solitary or confluent, as much as 4 mm. diam.; filaments compact, not separating easily under pressure; sheath thin, scarcely distinct, hyaline or yellow; trichomes 2.5-5 μ thick, blue-green, attenuate upwards into a slender hair; lower cells scarcely longer than broad, upper shorter.

On rocks and stones, corallines and other algæ, between the tide-marks. Common.

var. **hemisphærica** Born. & Flah.—Thallus hemispherical, firm, solitary or confluent, 3-5 mm. in diam.; trichomes 2.5-5 μ in diam.

var. **confuens** Farlow.—Thallus a flat confluent mass, 2-5 cm. across; trichomes 5-7 μ in diam. Rather rare; Devon and Northumberland.

3. **R. nitida** J. G. Agardh. (*R. plicata* Carm.). Lat. *nitidus*, polished.—Thallus spherical and hollow or expanded and corrugate,

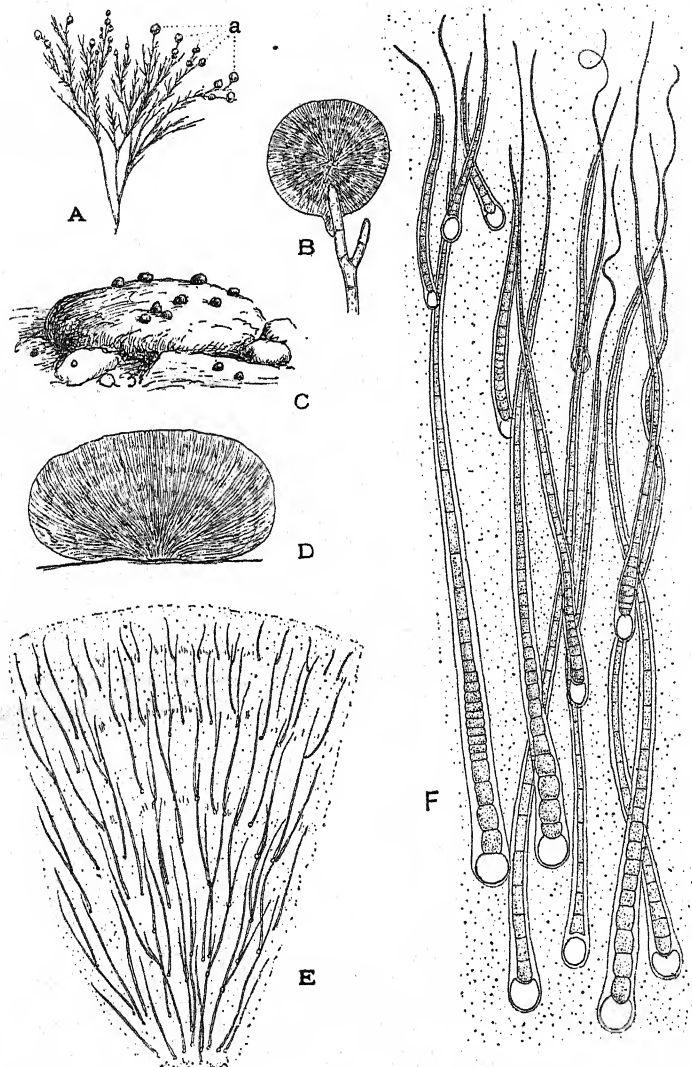


Fig. 26.—*Rivularia atra* Roth. A. Colonies (a) on host ($\times \frac{3}{8}$); B. ($\times 6$); C. Colonies on stone ($\times \frac{3}{8}$); D. Long. sect. ($\times 9$); E. Portion of colony ($\times 45$); F. Do. showing basal heterocysts ($\times 300$).

as much as 3 cm. in diam., olive-green; filaments closely packed; sheath narrow, indistinct below, more conspicuous above, yellowish brown or colourless; trichomes $2-5\mu$ broad, olive-green, attenuate upwards terminating in a hair; cells 3-4 times

as long as broad near the base of the colony, upper cells shorter.

On marine rocks about high-water mark, or places only occasionally covered by sea-water. Not uncommon.

4. *R. bullata* Berk. (*R. nitida* Desm.). Lat. *bullatus*, blistered.—Thallus globose or lobed, firm, as much as 1.25 cm. in diam., tufted or gregarious, much compressed when young, later hollow and inflated; substance elastic, not easily torn, deep blue-green; heterocysts basal; filaments 5–10 μ broad, attenuate upwards, ending in a long hair.

On marine rocks at half-tide level. Rare; south coast and Channel Islands.

5. *R. mesenterica* Thur. Gr. *mesos*, middle, *enteron*, intestine.—Frond vesiculose, more or less expanded, somewhat inflated, olivaceous or greenish, as much as 4 cm. broad, substance firm; filaments closely united, sheath compressed, narrow, hardly distinguishable, hyaline, often yellowish; trichomes 7–12 μ broad, attenuate upwards, ending in a hair; lower cells as long as broad, upper ones 3 times as broad as long, slightly contracted at the cross-wall.

Rare; Devon.

6. *R. australis* Harv. Lat. *australis*, southern.—Thallus at first hemispherical, later confluent, finally almost globose, 2 cm. broad, dark green, substance gelatinous; sheath indistinct, hyaline or yellowish; trichomes 3 μ broad at the base, enlarging upwards to 5–7.5 μ , finally attenuate into a hair; lower cells somewhat elongate, upper ones 3 times as long as broad, somewhat contracted at the cross-wall.

Rare; Devon.

Family II.—STIGONEMATACEÆ

Filaments free, or forming a pannose or pulvinate stratum, or united into definite colonies, more or less gelatinous; composed of one or more series of cells in each sheath, resulting from cell-divisions in two or more planes; branches connately joined, or sometimes true and false branches present; cells cylindrical, subspherical or irregularly angular; heterocysts intercalary or terminal. Propagation by hormogonia and by resting spores.

1. MASTIGOCOLEUS Lagerh.

(Gr. *mastix*, a whip, and *koleos*, a sheath.)

Filaments associated into tangled masses, branched, boring into mollusc shells or calcareous rock; one or more trichomes in each sheath, attenuate at the apices, terminating into long hyaline hairs; branching both true and false; heterocysts single, terminal or on short lateral branches. Hormogonia formed in the piliferous branches.

M. testarum Lagerh. Lat. *testa*, shell.—Forming thin membranaceous layers at first, later boring into mollusc shells, pale blue-green; filaments contorted, 6–10 μ thick; sheaths delicate, hyaline; trichomes 3.5–6 μ thick, cells cylindrical or subcylindrical; heterocysts elliptical or spherical, 6–18 μ diam.

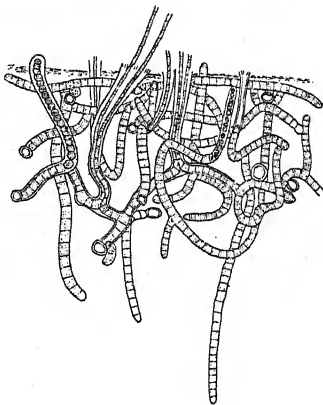


Fig. 27.—*Mastigocoleus testarum* Lagerh. Colony ($\times 220$).
(After Bornet and Flahault.)

2. BRACHYTRICHIA Zan.

(Gr. *brachus*, short, and *thrix*, a hair.)

Thallus formed of filaments united into a gelatinous mass; filaments flexuose, arcuate, attenuate into a hair at the apices, branching both true and false; sheath distinct and tubular in young filaments, later confluent; heterocysts intercalary.

B. Balani Born. & Flah.

Balanus, the acorn barnacle.—

Thallus black or brown, about

6 mm. in diam.; trichomes 5–6 μ broad, torulose; cells very irregular, spherical, oblong, or disc-like and as much as 3 times as broad as long; heterocysts much larger than the other cells.

Very rare; Devon and Dorset.

Family III.—SCYTONEMATACEÆ

Filaments differentiated into a basal and a terminal portion, simple or branched, formed of a single cell row; hairs absent.

1. MICROCHÆTE Thur.

(Gr. *mikros*, small, and *chaite*, loose flowing hair.)

Filaments simple, fixed at the base, erect; trichomes single in each sheath. Resembling *Calothrix*, but distinguished by the filaments never terminating in a hair.

Key.

Filaments 6–7 μ broad, forming greyish patches on old shells	<i>M. grisea</i> .
Filaments 12 μ broad, occurring in stellate tufts on other algæ	<i>M. æruginæa</i> .

M. grisea Thur. Lat. *griseus*, grey.—Thallus tomentose, orbicular, blue-green or greyish, becoming violet when old; filaments about 1 mm. long, 6–7 μ in diam., arcuate, swollen at the base; sheath thin, hyaline; trichomes 5–6 μ broad, olive-

green; articulations 2-3 times broader than long; heterocysts basal, hemispherical.

Forming patches on old shells.

Closely resembling *Calothrix*, except that the filaments end in a rounded cell, not a hyaline hair.

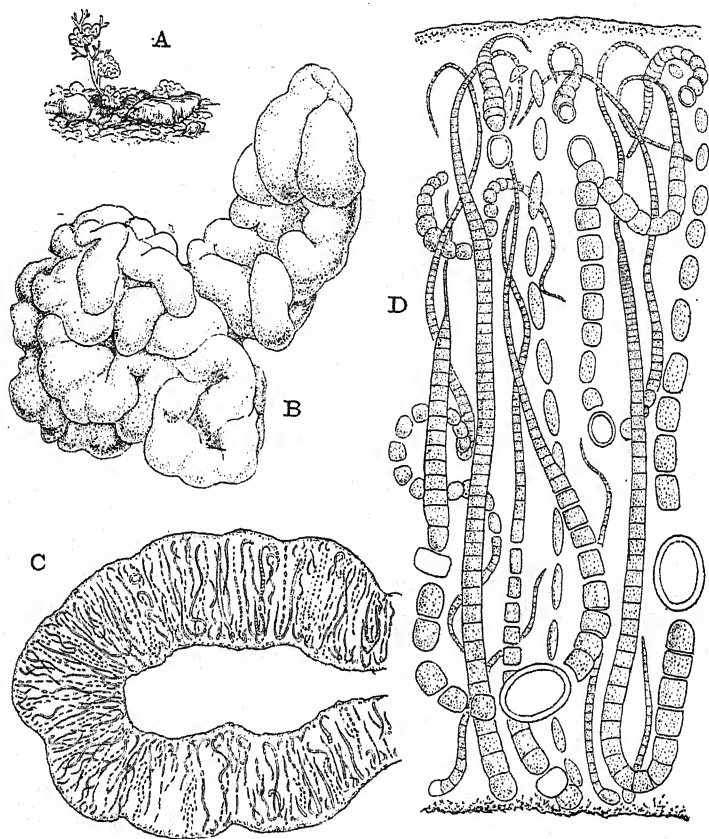


Fig. 28.—*Brachytrichia Balani* Born. & Flah. A. Colonies ($\times 3$); B. ($\times 6$); C. Sect. of colony ($\times 60$); D. ($\times 930$).

M. æruginea Batt. Lat. *ærugineus*, *verdigris* - green.—Thallus tufted; filaments 12μ broad; trichomes $6-7\mu$ broad; articulations about twice as broad as long; sheath thin, uniform, hyaline; trichomes blue-green; heterocysts basal, oblong or hemispherical.

Occurring in stellate tufts on the fronds of *Rhodochorton Rothii* and *R. floridulum* in shallow sandy pools near high-water mark. Berwick.

Family IV.—NOSTOCACEÆ

Thallus floating, single or gregarious; of definite globular, ovoid or regularly lobate form, or irregularly expanded, solid or hollow, soft to firmly gelatinous; trichomes unbranched, never attenuate and ending in a hair, both extremities similar;

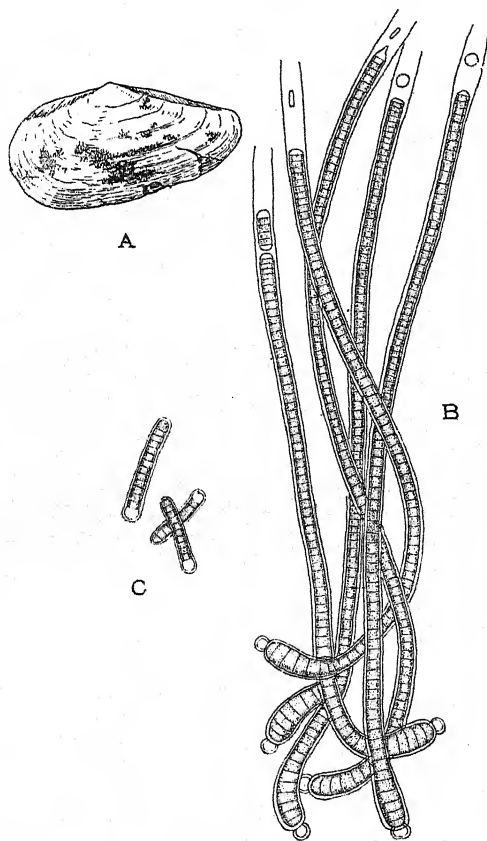


FIG. 29.—*Microchaete grisea* Thur. A. Colonies on old shell ($\times 3$); B. Group of trichomes ($\times 300$); C. Hormogonia ($\times 300$).

heterocysts present. Propagation by hormogonia and resting spores.

1. NOSTOC Vaucher

(Name used by Paracelsus.)

Thallus mucous, gelatinous or coriaceous, usually oblong or globose when young, later assuming a variety of forms, solid

or hollow, usually with a firm exterior, floating or attached, composed of numerous intertwined, contorted filaments with thin walls and a thick gelatinous sheath; trichomes usually torulose, cells cylindrical or subglobose; heterocysts terminal. Intercalary spores present, spherical to oblong, seriate, beginning midway between the heterocysts and developing centrifugally.

Key.

Microscopic, among and in the cells of other algæ ... *N. entophyllum*.
 Forming roundish gelatinous masses among
Enteromorpha and other algæ *N. Linckia*.

N. entophyllum Born. & Flah. Gr. *entos*, within, *phyton*, a plant.—Thallus minute, not visible to the naked eye, blue-green or brownish, densely aggregate; sheath distinct, more or less hyaline or dingy brown; trichomes $2.5-3\mu$ broad, torulose; vegetative cells flattened or spherical; heterocysts larger than neighbouring cells. Spores spherical or flattened, $5-6\mu$ broad, rarely oblong, 8μ or more in length.

Among and in the cells of other algæ. Rare; Cumbrae.

N. Linckia Born. (*Monormia intricata* Berk.). *Linckia* Mich., an old genus of blue-green algæ.—Thallus gelatinous, forming roundish colonies, æruginous or brownish with age; filaments contorted, intertwined or spiral, enclosed in a conspicuous sheath; trichomes $3.5-4\mu$ in diam.; cells spherical or flattened; heterocysts $5-6\mu$ in diam., globose or sub-globose. Spores seriate, developing on either side of the heterocysts, sub-globose, $7-8\mu$ by $6-7\mu$; membrane hyaline or brownish, smooth.

Rare; Gloster, Kent, Norfolk and Cumbrae.

2. ANABÆNA Bory

(Gr. *anabaino*, I rise up, mount.)

Trichomes cylindrical or slightly tapering at the ends, without a sheath, or in some species with a thin mucous tegument; existing apart or united loosely into a stratum; heterocysts intercalary. Spores single or seriate, spherical to cylindrical.

Key.

Trichomes curved, entangled; spores elliptical $1\frac{1}{2}$
 times as long as broad *A. variabilis*.
 Trichomes straight or very slightly curved; spores
 oblong, 2-3 times as long as broad *A. torulosa*.

A. variabilis Kütz. (*Sphærozyga Thwaitesii* Harv.).—Forming a thin gelatinous stratum; trichomes flexuose, moniliform, mucilaginous, $4-6\mu$ in diam., terminal cell obtuse, conical; heterocysts spherical or oval, 8μ by 6μ . Spores elliptical, usually

seriate, developing centrifugally from midway between the heterocysts; walls brownish, smooth.

In brackish water. Probably not uncommon: widely distributed.

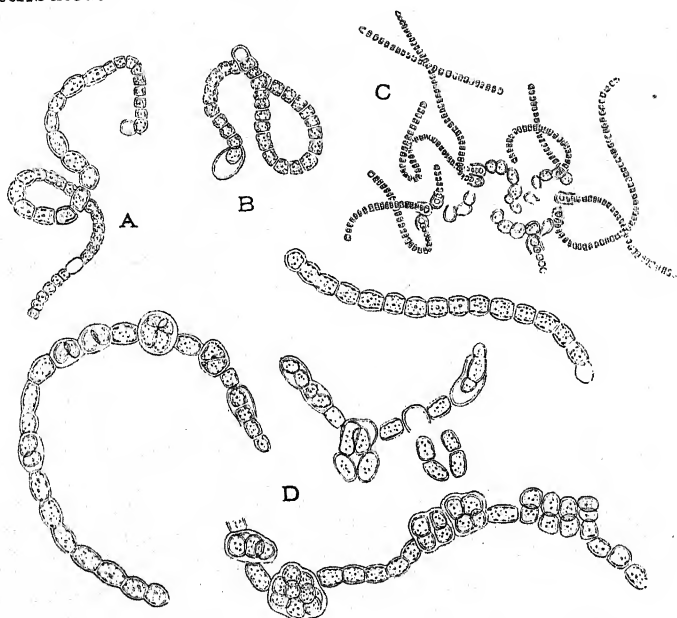


Fig. 30.—*Nostoc Linckia* Born. A. Portion of trichome with spores ($\times 430$); B. Germinating spore ($\times 430$); C. Group of germinating spores ($\times 220$); D. Spores obtained in culture ($\times 430$). (After Bornet and Thuret.)

A. torulosa Lagerh. (*Sphaerozyga Carmichaelii* Harv.).
 Lat. *torulosus*, cylindric with swollen portions at intervals.
 —Forming a thin stratum, consisting of free, simple, moniliform trichomes, interrupted by somewhat angular heterocysts. Spores elongated, oblong, 2 or 3 times as long as broad, beginning from the cells nearest the heterocysts and developing centrifugally.

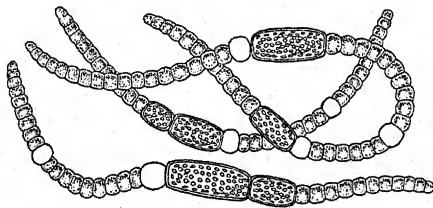


Fig. 31.—*Anabaena torulosa* Lagerh. Colony showing spores and heterocysts ($\times 440$).

On decaying heaps of marine algæ and in brackish water. Not uncommon; widely distributed.

Species inquirendæ.

A. Broomei Batt. (*Sphærozyga Broomei* Thur.). After C. E. Broome, British cryptogamist.—“Spores numerous, elliptical, twice as long as wide, not much exceeding in width the ordinary cells, commencing to be formed from the cells nearest the connecting cells; connecting cells smooth, subquadrate, rather longer than wide.” (Thwaites’s MSS.)

On dead leaves of *Myriophyllum* in a brackish ditch. Gloster, near Bristol.

A. Berkeleyana Batt. (*S. Berkeleyana* Thwaites). After the Rev. M. J. Berkeley, British cryptogamist.—“Spores large, twice the width of the ordinary cells, oblong, half as long again as wide, becoming brown when mature, generally two on each side the connecting cell, which is sphæroidal, slightly compressed. Young filaments included, one or several together, in a defined mucous sheath.” (Thwaites’s MSS.)

“Scattered among the filaments of *Conferva fracta*,” in a brackish ditch. Gloster.

3. NODULARIA Mert.

(Lat. *nodulus*, a little knot, referring to the intercalary heterocysts.)

Filaments free, simple, moniliform or cylindrical, consisting of ordinary vegetative cells and intercalary heterocysts; sheath delicate, enclosing one trichome. Resting spores formed from vegetative cells.

Key.

Cells almost as long as broad; spores spherical ... *N. Harveyana*.
Cells much shorter than their breadth; spores
elliptical *N. spumigena*.

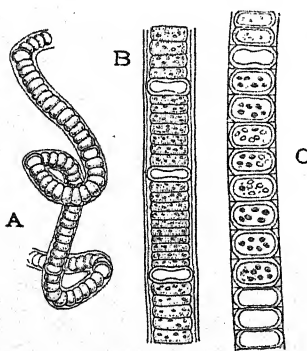


Fig. 32.—*Nodularia spumigena* Mert. var. *litorea* Born. & Flah. A. Filament ($\times 220$); B. Portion showing heterocysts ($\times 430$); C. showing spores ($\times 430$).

N. Harveyana Thur. After W. H. Harvey, Irish algologist. (*Spermosira Harveyana* Thwaites).—Filaments much curved, cells almost as long as broad; heterocysts subquadrate, rather longer than wide, equal in breadth to ordinary cells; sheath inconspicuous. Spores spherical, intercalary, moniliform, nearly twice the diam. of the cells.

Rare; Gloster, Northumberland and Wales.

N. spumigena Mert. var. *litorea* Born. & Flah. (*Spermosira litorea* Kütz.). Lat. *spuma*, foam, genus, offspring.—

Forming a deep green fleecy covering to floating plants on which it occurs; filaments straight or curved, simple, cylindrical; sheath delicate; cells lenticular, much shorter than their breadth; heterocysts compressed, sometimes reddish. Spores elliptical, intercalary, in chains, deep brown when mature.

Rare; widely distributed

CHLOROPHYCEÆ

Key to Genera.

1. Thallus of one or more uninucleate cells 2.
- Thallus coenocytic 11.
2. Cells in non-filamentous colonies or solitary 3.
- Thallus formed of cells united into filaments 16.
3. Cells spherical, free-floating Halosphæra (p. 54).
- Cells not free-floating 4.
4. Endophytic 5.
- Not endophytic 6.
5. Cell ovoid, with rudimentary stipe ... *Codolum Petrocelidis* (p. 53).
- Cell without stipe Chlorochytrium (p. 49).
6. Zoospores formed within an inner investing wall Sykidion (p. 51).
- No inner investing wall 7.
7. Cell attached by a stipe formed by the elongation of its wall 8.
- Cell without stipe formed from its own wall 9.
8. Forming slippery patches on rocks ... *Codolum* (p. 53).
- Epiphytic on *Pilayella* and other Algæ Characium (p. 52).
9. Cells united into a conspicuous gelatinous layer 10.
- Gelatinous layer not conspicuous, cells united into colonies, sometimes appearing filamentous Protococcus (p. 51).
10. Cells embedded in amorphous jelly, daughter cells included in the persistent wall of the mother cell Gloeocystis (p. 56).
- Cells in gelatinous mass, having the form of branching filaments Prasinocladus (p. 54).
11. Thallus vesicular Halicystis (p. 98).
- Thallus otherwise 12.
12. Filaments interwoven to form a complex thallus Codium (p. 104).
- Filaments not so interwoven 13.
13. Occurring in the interior of shells of molluscs Ostreobium (p. 100).
- Growing elsewhere 14.
14. Erect axis with branches of one or more orders, mostly plumose Bryopsis (p. 97).
- Axis not erect 15.

15. Producing oogonia and antheridia;
zoospores multinucleate, at the ends
of the branches *Vaucheria* (p. 102).
No sexual organs; zoospores uni-
nucleate, in sporangia shut off from
the frond by a double wall *Derbesia* (p. 99).
16. Thallus filamentous, the filaments
occasionally united laterally into a
pseudo-parenchymatous disc 17.
Thallus membranous, flat or tubular 36.
17. Living in the substance of the shells of
molluscs *Gomontia* (p. 96).
Not shell-boring 18.
18. Filaments united laterally into a
pseudo-parenchymatous membrane 19.
Filaments not so united 23.
19. Forming a regular monostromatic disc 20.
Forming a polystromatic disc 22.
20. Setæ or hairs more or less abundant... *Ochlochæte* (p. 58).
Neither setæ nor hairs 21.
21. Disc formed of filaments radiating
from the centre *Pringsheimia* (p. 66).
Disc formed of irregular filaments ... *Endoderma* (p. 61).
22. Horizontal layer producing erect fila-
ments with terminal or lateral
sporangia *Pilinia* (p. 60).
Erect filaments absent *Ulvella* (p. 64).
23. Filaments unbranched, sometimes
with occasional short spine-like
ramuli 24.
Filaments branched..... 28.
24. Filaments of a single series of cells..... 25.
Filaments consisting in part of several
cell-series, not all in one plane,
filiform *Prasiola crispa* (p. 79).
25. Chromatophore a zonate band or
parietal disc *Ulothrix* (p. 55).
Chromatophore lining the cell, con-
tinuous or netted 26.
26. Cells more or less barrel-shaped 27.
Cells cylindrical; with tendency to
horizontal growth, and rhizoidal
branches *Rhizoclonium* (p. 93).
27. Filaments gelatinous, sometimes two
united laterally, sometimes with
short ramuli..... *Urospora* (p. 95).
Filaments not gelatinous, harsh to the
touch..... *Chætomorpha* (p. 90).
28. Endozoic or endophytic, more rarely
epiphytic 29.
On mud, stones, epiphytic, or free-
floating 34.
29. In outer coat of shells of molluscs ... *Tellamia* (p. 63).
Endo- or epiphytic 30.
30. In cell walls of algæ or among the cells
of *Zostera* *Endoderma* (p. 61).
Endophytic in the tissues of other
algæ, more rarely epiphytic; setæ
or hairs present 31.

- | | |
|---------------------------------------------------------------------------------------------------------------|-----------------------|
| 31. Hairs spiral | Phæophila (p. 58). |
| Hairs or setæ straight | 32. |
| 32. Setæ arising from small special cells... | Bolbocoleon (p. 59). |
| Setæ arising from cells of the filament | 33. |
| 33. Setæ arising from horizontal cells | Blastophysa (p. 61). |
| Setæ arising terminally from erect cells | Acrochate (p. 57). |
| 34. Branches usually short, many of them rhizoidal | Rhizoclonium (p. 93). |
| Branches similar to the axis | 35. |
| 35. Profusely branched, rhizoidal branches present; cell-division largely intercalary | Spongomorpha (p. 88). |
| No rhizoidal branches; cell-division chiefly terminal | Cladophora (p. 81). |
| 36. Thallus tubular | 37. |
| Thallus flat | 38. |
| 37. Cells in groups of four, which form easily separable longitudinal series | Capsosiphon (p. 75). |
| Seriatio less distinct or lacking | Enteromorpha (p. 67). |
| 38. Attached by one surface..... | Protoderma (p. 66). |
| Attached at the base of the thallus ... | 39. |
| 39. Frond narrow, attaining a length of several cm., 1-4 cells wide..... | Percursaria (p. 76). |
| Frond broad, membranaceous | 40. |
| 40. Membrane distromatic | Ulva (p. 76). |
| Membrane monostromatic | 41. |
| 41. Cells in more or less distinct series in two directions, plastid stellate; reproduction by akinetes | Prasiola (p. 78). |
| Cells not in series, plastid parietal; reproduction by motile spores ... | Monostroma (p. 72). |

Subclass.—ISOKONTÆ

Unicellular, multicellular or cœnocytic; reproduction by zoospores or planogametes with 2 or 4 equal cilia, or if multinucleate with the cilia arranged in pairs or in a circle, as in Derbesiaceæ.

Order I.—PROTOCOCCALES

Vegetative cells non-motile, solitary or in groups, rarely filiform; cells usually uninucleate, rarely multinucleate; plastid usually single, disc-like or cup-shaped.

Family I.—PROTOCOCCACEÆ

Unicellular, spherical or pyriform, rarely irregular; attached or free-floating. Asexual reproduction by zoospores or aplano-spores; sexual reproduction where known, by gametes.

1. CHLOROCHYTRIUM Cohn

(Gr. *chloros*, green, and *chutrion*, a small pot.)

Thallus endophytic, unicellular, round, oval or reniform; chromatophore with radial prolongations or continuously

covering the outer wall and having one or more pyrenoids. Asexual reproduction by 2- or 4- ciliate zoospores or by akinetes; sexual reproduction by 2-ciliate isogametes, conjugating before or after separation from the parent; resulting zygote motile with 4 cilia, later coming to rest and penetrating the host.

Key.

- | | |
|--------------------------------------------------------------------------|-----------------------------|
| 1. Vegetative cells sub-hemispherical, base flattened | <i>C. dermatocolax</i> (4). |
| Vegetative cells globose or elliptical | 2. |
| 2. Vegetative cells elliptical when single, irregular when crowded | <i>C. immersum</i> (1). |
| Vegetative cells globose | 3. |
| 3. With one pyrenoid, cells 16-26 μ in diam. | <i>C. Cohnii</i> (3). |
| With many pyrenoids, cells 80-100 μ in diam.... | <i>C. inclusum</i> (2). |

1. *C. immersum* Masee.—Cells ellipsoidal, irregular when crowded, depressed, neck short, protruding. Zoospores elongate-pyriform, with 2 cilia about three times the length of the body.

Sunk in the thallus of *Schizonema Dillwynii* and *Callithamnion roseum*. Yorkshire.

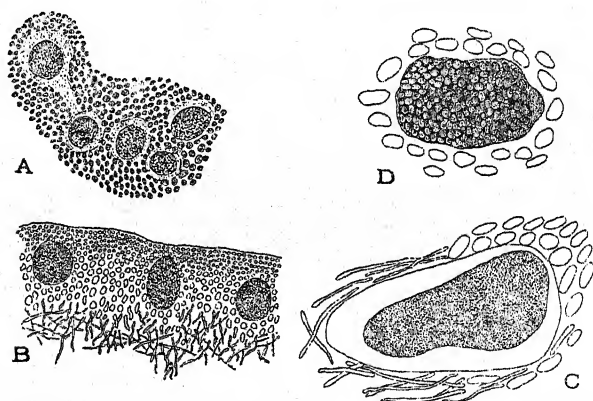


Fig. 33.—*Chlorochytrium inclusum* Kjellm. A. Surface view of host (*Dilsea edulis*) showing vegetative thalli ($\times 30$); B. Long. sect. ($\times 30$); C. Single thallus embedded in host ($\times 130$); D. Zoo. spores ($\times 130$).

2. *C. inclusum* Kjellm.—Vegetative thallus spherical or sub-spherical, 80-100 μ broad, becoming slightly elongate and conical during formation of zoospores, later flask-shaped, ovoid or ellipsoidal, the apex later protruding from the plant and forming an ostiole for the emission of spores; plastid covering the whole surface; many pyrenoids present.

Sunk in the thallus of *Dilsea edulis*. Common; widely distributed.

3. **C. Cohnii** Wright (*Chlorocystis Cohnii* Reinke). After Ferdinand Cohn, German botanist.—Cells $16-26\mu$ in diam., more or less spherical; plastid bright green, more or less star-shaped, usually only partly covering the cell-wall, but sometimes completely; one pyrenoid. Zoospores of two sizes, one spherical, $6-7\mu$ in diam., the other pyriform, $2.5-3.5\mu$ in diam., both 4-ciliate, escaping through an opening in the cell-wall; conjugation not observed.

On various species of *Schizonema*, *Polysiphonia* and other algæ. Not uncommon; widely distributed.

4. **C. dermatocolax** Reinke. Gr. *derma*, skin, and *kolax*, an imitator.—Cells $30 \times 20\mu$, rounded or oval seen from above, nearly plane from below; external surface convex, subhemispherical or sub-conical. Asexual reproduction by zoospores $4-6\mu$ long, escaping by an opening in the end of the papilla formed at the apex of the cell.

Rare; Northumberland, Wales and S.W. Scotland.

2. PROTOCOCCUS Rabenh.

(Gr. *protos*, first, and *kokkos*, a seed.)

Cells globose or angular by mutual pressure, solitary or irregularly aggregated; wall thin, contents bright green, granular; plastid single, usually saucer-shaped, often lobed. Vegetative reproduction by cell-division; other forms of reproduction very rare.

P. marinus Kütz.—Cells globose or slightly irregular, simple, free, 60μ in diam., with dark reddish granular contents.

Occurring among other algæ. Rare; Dorset.

3. SYKIDION Wright

(Gr. *sukidion*, a small fig.)

Plants epiphytic, vegetative thallus consisting of a single cell, sessile or substipitate; plastid more or less cup-shaped. Reproduction by 2-ciliate zoospores formed within an inner cell-wall, and escaping through the apical portion of the cell; aplanospores also formed.

S. Dyeri Wright. After Sir W. Thiselton Dyer, British botanist.—Cells globose, subpyriform or irregularly pentagonal,

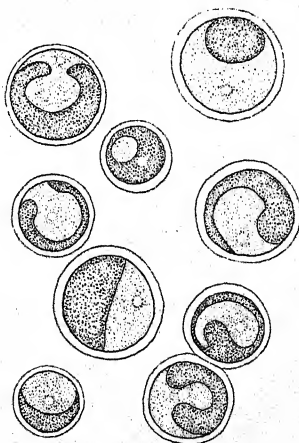


Fig. 34.—*Protococcus marinus* Kütz. Vegetative cells ($\times 400$).

attached by a narrow basal portion: cell contents bright green.

Epiphytic on *Rhizoclonium*. Rare; Ireland and Wales.

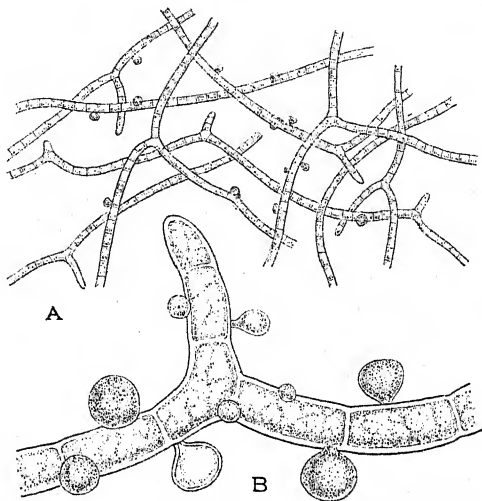


Fig. 35.—*Sykidion Dyeri* Wright. Epiphytic on *Rhizoclonium riparium* var. *Casparyi*. A. ($\times 60$); B. ($\times 300$).

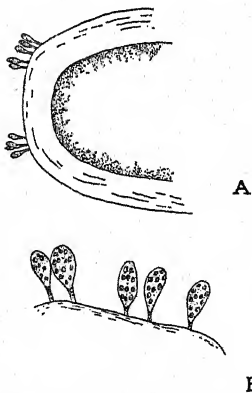


Fig. 36.—*Characium marinum* Kjellm. A. Epiphytic on *Pilayella littoralis* ($\times 60$); B. Plants ($\times 250$). Individual plants attached to host.

4. *CHARACTIUM* A. Br.

(Gr. *characion*, a small stake or pole.)

Unicellular, solitary, epiphytic, round, elongate or ellipsoid, ovoid; apex rounded or acute, attached by a pedicel formed by the prolongation of the cell-wall; plastid bell-shaped, with one pyrenoid. Reproduction by large and small spores (macro- and microzoospores?); fusion not observed.

C. marinum Kjellm.—Obovoid, sometimes scarcely stipitate, 40μ by 12.5μ .

On *Pilayella littoralis* and other algæ. Probably not uncommon; Berwick and Cumbrae.

5. CODIOLUM A. Br.

(From *Codium*, a genus of the Chlorophyceæ.)

Unicellular, ovoid, sub-cylindrical or clavate; cell-wall prolonged into a pedicel with flattened expansion for attachment; plastid with several pyrenoids. Asexual reproduction by 4-ciliate zoospores formed in large numbers in the cell.

Key.

- | | |
|------------------------------------------------------------------------------------------|-----------------------------|
| 1. Cells with a long pedicel | 2. |
| Cells with the pedicel short or wanting | <i>C. Petrocelidis</i> (3). |
| 2. Cells up to 1.5 mm. long, clavate head 2-3 times
as broad as hyaline pedicel | <i>C. gregarium</i> (1). |
| Cells up to 2-5 mm. long, clavate head $1\frac{1}{2}$ times
as broad as pedicel | <i>C. pusillum</i> (2). |

1. **C. gregarium** A. Br.—Clavate head narrow, delimited from the hyaline pedicel, up to 500μ by 100μ ; pedicel unbranched, almost cylindrical, slightly enlarging upwards, up to 1 mm. long, $20-30\mu$ broad, with disc-like basal attachment.

Forming slippery green patches on the surface of rocks near high-water mark. Rare; Devon and Berwick.

2. **C. pusillum** Foslie. Lat. *pusillus*, very small.—Cells 2-5 mm. long; apex obtuse, $30-60\mu$ in breadth at the clavate head, $8-14\mu$ near the base; head and pedicel usually of about equal length.

On rocks in the littoral belt. Rare; widely distributed.

3. **C. Petrocelidis** Kuck.—Clavate head ovoid or obovoid, $65-90\mu$ by $20-30\mu$; pedicel short or absent, often tapering below into a sharp point.

Growing within the thallus of species of *Petrocelis*. Not uncommon; Northumberland and Scotland.

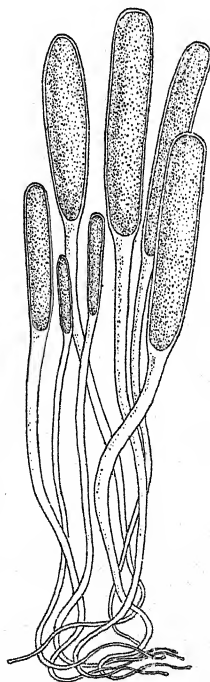


Fig. 37.—*Codiolum gregarium*
A. Br. Plants ($\times 30$).

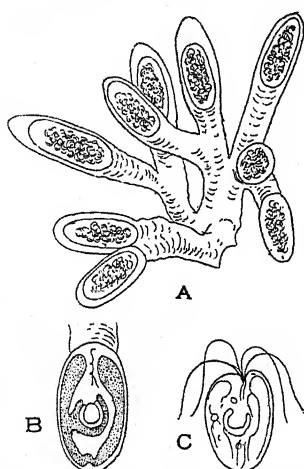


Fig. 38.—*Prasinocladus lubricus* Kuck. A. Portion of colony ($\times 625$); B. Single cell ($\times 850$); C. Zoospore ($\times 850$).

6. PRASINOCLADUS Kuck.

(Lat. *prasinus*, grass-green, and Gr. *klados*, a branch.)

Cells borne on much-branched gelatinous stipe; plastid plate-like when young, later filling the cell, pyrenoid bowl-shaped enclosing the nucleus. Asexual reproduction by longitudinal division, rarely transverse, also by formation of 4-ciliate zoospores with eye-spot; sexual reproduction not observed; akinetes not known.

P. lubricus Kuck. Lat. *lubricus*, slippery.—Cells unicellular, borne in colonies on a branched gelatinous stipe; vegetative cells oval, $13\text{--}20\mu$ by $7\text{--}11\mu$; plastids plate- or ribbon-like.

Very rare; Plymouth.

Family II.—HALOSPHERACEÆ

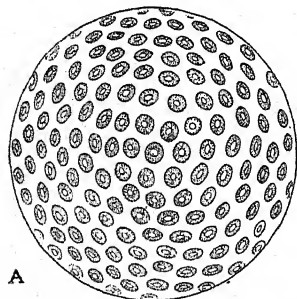


Fig. 39.—*Halosphæra viridis* Schmitz. A. During formation of zoospores; B. Part of the peripheral plasma during formation of zoospores; C. Zoospore. (B. and C. after Gran and Schmitz.)

Unicellular, spherical, relatively large; cell thin-walled, uninucleate with numerous disc-shaped plastids. Asexual reproduction by zoospores and aplanospores.

1. HALOSPHERA Schmitz

(Gr. *hals*, the sea, and *sphaira*, a sphere.)

Cells globular, free-floating, uninucleate; plastids numerous, parietal. Asexual reproduction by 2-ciliate zoospores.

H. viridis Schmitz. Lat. *viridis*, green.—Minute, $550\text{--}620\mu$ broad; cell-wall hyaline, thick, vacuole central; plastids parietal, numerous, irregularly angular, pale green; pyrenoids large, spherical; nucleus single, nucleolus obscure. Zoospores acutely conical, elongate, with 2 cilia.

Probably not uncommon; Plymouth.

Order II.—ULOTRICHALES

Simple or branched filaments, sometimes membranaceous, rarely in groups; cells uninucleate; plastid usually single, ribbon-, disc-, net- or star-shaped, usually with one or more pyrenoids.

Family I.—ULOTRICHACEÆ

Frond usually an unbranched, uniseriate filament, rarely partly multiseriate; cells uninucleate, all capable of producing spores, with the exception of the basal cell; plastids ribbon-like, disc-shaped or forming a network, usually with one or more pyrenoids. Asexual reproduction by 2- or 4-ciliate zoospores, by akinetes or aplanospores; sexual reproduction by the conjugation of 2-ciliate zoogametes.

1. ULOTHRIX Kütz.

(Gr. *oulos*, shaggy, and *thrix*, a hair.)

Filaments simple or rarely branched, composed of a single series of uninucleate cells, all capable of division and spore-production, except the basal attachment cell; filaments grass-green, soft and flaccid, at first forming tufts attached at the base, later becoming entangled; cells never long in proportion to their breadth; plastid ribbon-like with one or more pyrenoids. Asexual reproduction by akinetes and aplanospores, also by 4-ciliate zoospores, formed 1-4 in each cell; sexual reproduction by 2-ciliate gametes, formed 8 or more in a cell, germinating after conjugation. External conditions may induce modifications of the normal processes, filaments breaking up into individual cells and passing into a *Palmella* stage.

Key.

- | | |
|----------------------------------------------------------------------|-------------------------|
| 1. Cells of the filaments shorter than broad | 2. |
| Cells as long as, or longer than broad | <i>U. implexa</i> (1). |
| 2. Cells 10-25 μ broad; not markedly gelatinous ... | <i>U. flacca</i> (2). |
| Cells more than 25 μ broad; gelatinous and glossy when dry | <i>U. speciosa</i> (3). |

1. *U. implexa* Kütz. (*Lyngbya Outleriae* Harv.). Lat. *implexus*, interwoven.—Forming soft light green tufts, individual filaments curved but not twisted; cells sometimes slightly swollen at the middle, almost quadrate, 6-15 μ in diam.; plastid occupying only the middle of the cell when young, often an incomplete ring. Fertile cells not swollen or increased in width.

On rocks or stones in estuaries. Rare; widely distributed.

2. *U. flacca* Thur. (*Lyngbya flacca* Harv. and *L. Carmichaelii* Harv.). Lat. *flaccus*, flabby.—Forming bright or dark green

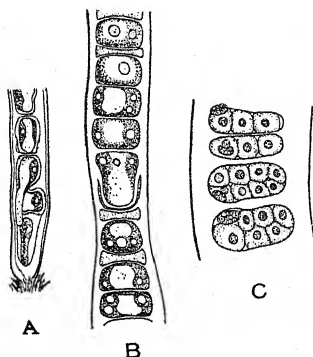


Fig. 40.—*Ulothrix flacca* Thur. A. Base of filament ($\times 380$); B. Portion of vegetative filament ($\times 380$); C. Cells containing gametes ($\times 450$).

tufts; cells $10\text{--}25\mu$ in diam., shorter than broad; filaments simple or bearing a few slender branchlets; cells attaining 50μ diam. during spore formation, swollen in the middle; plastid occupying the whole of the cell, with 1-3 or more pyrenoids; substance soft, adhering to paper.

On rocks and various algae between the tide-marks. Not uncommon.

3. *U. speciosa* Kütz. (*Lyngbya speciosa* Carm.). Lat. *speciosus*, showy.—Forming widely spreading strata covering rock surfaces and Fuci. Filaments almost twice as

broad as in *U. flacca*, at first straight, later becoming curled and crenate; plastid filling the cell.

Rare; widely distributed.

Family II.—CHÆTOPHORACEÆ

Fronds generally filamentous, usually much branched, sometimes united into disc-like expansions; cells uninucleate, with band or disc-shaped plastids, often somewhat divided or with projections, pyrenoids one or rarely more; hairs usually present, varying in character. Asexual reproduction by 4-ciliate or 2-ciliate zoospores, by aplanospores and akinetes; sexual reproduction by gametes in some genera.

1. GLÆOCYSTIS Naeg.

(Gr. *gloios*, gelatinous, and *kustis*, a bladder.)

Cells spherical or ovoid with thick wall, solitary or several together in a common gelatinous sheath; protoplast often containing reddish oil-drops. Vegetative reproduction by cell-division in three directions; asexual reproduction by 2-ciliate zoospores; akinetes also formed.

G. adnata Naeg.—Thallus laterally expanded, gelatinous, firm, yellowish brown; cells globose or oblong, twice as long as broad, $7.5\text{--}12.5\mu$ broad; protoplast brownish green, granular; sheath hyaline, striate.

Rare; South Coast and Berwick.

2. **ACROCHÆTE** Pringsh.(Gr. *akros*, the apex, and *chaite*, a bristle.)

Thallus microscopic, epiphytic, consisting of creeping branched filaments; branches small, irregular, sometimes erect, ending in a colourless hair. Zoospores numerous, developed in one of the cells of the procumbent branches or in the end cell of the branchlets.

*Key.*Cells 2-6 times as long as broad *A. repens*.Cells less than twice as long as broad *A. parasitica*.

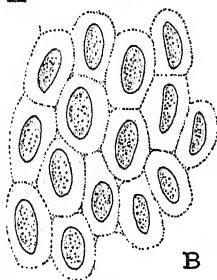
A. repens Pringsh. Lat. *repens*, creeping.—Vegetative cells elongate, $7-9\mu$ thick and 2-6 times as long as broad; short erect branches often unicellular, ending in a hyaline hair. Zoospores frequently formed in the end cells of the branchlets.

Creeping on the surface of *Chorda Filum*, *Leathesia*, and other algæ. Rare; Dorset and Cumbrae.

A. parasitica Oltm.—Creeping filaments $8-12\mu$ in diam.; cells about $1\frac{1}{2}$ times as long as broad; plastid disc-



A



B



C

Fig. 41.—*Glæocystis adnata* Naeg. A. ($\times \frac{2}{3}$); B. Vegetative cells ($\times 600$); C. Zoospores ($\times 600$).

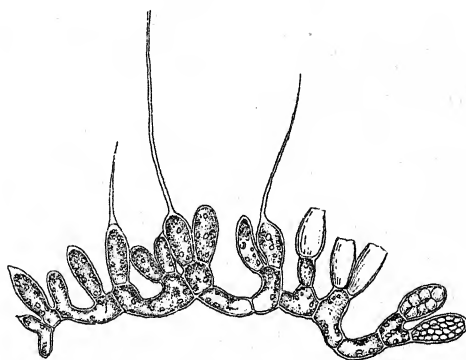


Fig. 42.—*Acrochaete repens* Pringsh. ($\times 280$).
(After Pringsheim.)

shaped, one pyrenoid. Sporangia sub-clavate, usually projecting above the surface of the host plant, about 25μ by $10-12\mu$.

In old fronds of *Fucus*. Probably common; Northumberland and Devon.

3. **PHÆOPHILA** Hauck(Gr. *phaios*, brown, and *philos*, friend.)

Thallus microscopic, epiphytic, consisting of creeping, branched, articulated filaments; cells large, soft, colourless, often bearing elongate hyaline hairs. Zoospores numerous, formed in the vegetative cells.

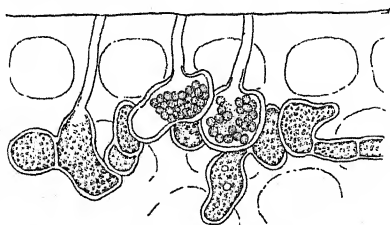


Fig. 43.—*Phæophila dendroides* Batt. Showing vegetative cells and zoospores. ($\times 200$.) (After Huber.)

P. dendroides Batt.

(*Ochlochaete dendroides* Crouan and *Phæophila floridearum* Hauck). Gr. *dendron*, a tree, *eidos*, resemblance.—Filaments irregularly branched, between the cortical cells of the larger algæ, or creeping on the surface

of the thallus; rarely forming a continuous cell-layer; cells $12-40\mu$ thick, longitudinally elongate, swollen at intervals, sometimes bearing hyaline hairs.

On other algæ and *Zostera*. Rare; Dorset.

4. **OCHLOCHÆTE** Thwaites(Gr. *ochlos*, a multitude, and *chaite*, a bristle.)

Much branched procumbent filaments adpressed to the surface of the host; cells longitudinally elongate, not swollen at the base.

Key.

On grass stems in brackish water *O. hystrix*.
Epiphytic on other algæ and *Zostera*; marine *O. ferox*.

O. hystrix Thwaites. Gr. *hystrix*, a porcupine.—Disco-like, frequently irregular in outline, minute, pale green, hoary; filaments closely adpressed, adhering firmly to the substratum, radiating from a central point, irregularly branched, frequently cohering laterally; cells oblong, cell-wall elongated into a rigid tubular bristle. Fructification not known.

On stems of grasses in brackish water. Very rare; Studland and Bristol.

O. ferox Huber. Lat. *ferox*, fierce.—Filaments radiating from a centre, more or less closely united to form a round or irregular disc; branching lateral, an occasional branch rising above the rest and forming locally a tissue 2 cells thick; cells round or angular, as much as 30μ in diam.; plastid parietal with one pyrenoid; setæ tubular, continuous with the cells.

Central cells enlarged to form sporangia, as much as 30μ in diam.

Epiphytic on other algæ. Rare; S.W. Scotland.

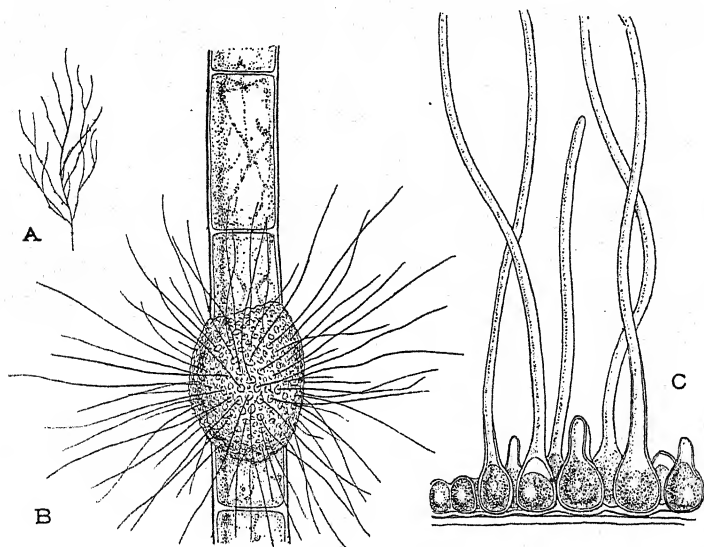


Fig. 44.—*Ochlochaete ferox* Huber. A. On *Chaetomorpha* ($\times \frac{1}{2}$); B. ($\times 60$); C. Long. sect. ($\times 300$).

5. BOLBOCOLEON Pringsh.

(Gr. *bolbos*, a bulb, and *koleos*, a sheath.)

Thallus minute, epiphytic or creeping among the tissues of other algæ; filaments creeping, branched, formed of rounded or

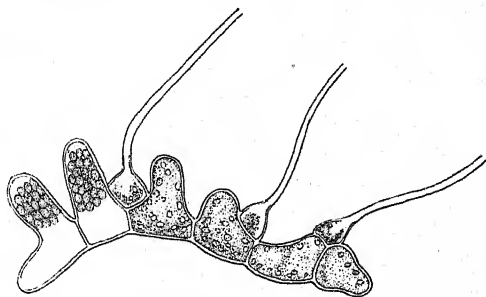


Fig. 45.—*Bolbocoleon piliferum* Pringsh. ($\times 160$.) (After Pringsheim.)

horizontally elongated cells bearing on their upper sides single or clustered cells prolonged into hyaline hairs; plastid of the

non-piliferous cells plate-like, perforate, with 5-10 pyrenoids, that of the piliferous cells irregular, toothed, with 2 pyrenoids. Zoospores produced from the non-piliferous cells on the upper side.

B. piliferum Pringsh. Lat. *pilus*, a hair, *fero*, I bear.—Non-piliferous cells $12-16\mu$ in diam. and 2-4 times as long as broad; piliferous cells swollen at the base.

On the surface of various algæ. Probably common; widely distributed

6. PILINIA Kütz.

(Lat. *pilus*, a hair.)

Tufts densely aggregate, crustaceous, thin, spongy, olive-green; erect filaments arising from procumbent filaments. Zoosporangia sub-spherical, bearing 20-35 zoospores, formed at the end of the branches. On wood, stones and shells.

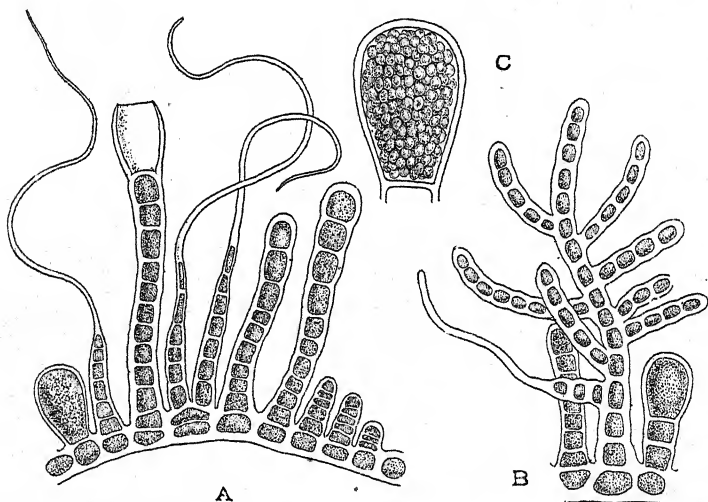


Fig. 46.—*Pilinia rimosa* Kütz. A. Erect filaments arising from procumbent filaments ($\times 400$); B. Much branched filament ($\times 400$); C. Zoosporangium ($\times 850$).

P. rimosa Kütz. Lat. *rimosus*, having cracks.—Crustaceous, adnate to the host, having pores at first, traversed later by cracks and fissures, mucilaginous, $335-600\mu$ high; filaments much branched; vegetative cells $5-8.5$ rarely 9.5μ long, diam. equal to twice the length.

On wood, stones and shells. Dorset, Norfolk and Northumberland.

7. BLASTOPHYSA Reinke

(Gr. *blastos*, a bud, and *phusa*, a bladder.)

Thallus bladder-like, minute, multinucleate; plastid parietal, plate-like, polygonal.

B. rhizopus Reinke. Gr. *rhiza*, a root, *pous*, a foot.—Vesicle minute, 50–120 μ in diam., bearing elongate colourless rhizoidal filaments and sometimes colourless hairs; plastids

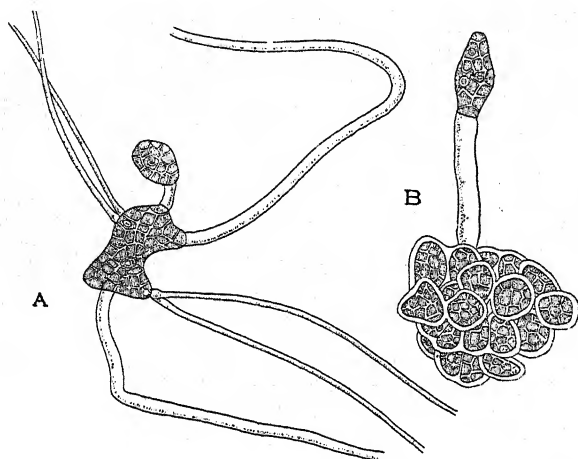


Fig. 47.—*Blastophysa rhizopus* Reinke. A. Vesicle with two rhizoids and two groups of hairs; B. Vesicle showing daughter cells and formation of new plant at the apex of a rhizoid ($\times 150$). (After Reinke.)

angular, forming a reticulum; cells multinucleate. Reproduction by the formation of numerous daughter cells within the mother cell, also by the formation of new cells at the tips of the rhizoids.

Epiphytic on *Hildenbrandia* and on the attachment organ of *Dumontia filiformis*. Rare; widely distributed.

8. ENDODERMA Lagerh. (incl. **EPICLADIA** Reinke)(Gr. *endon*, inside, and *derma*, a skin.)

Plants microscopic; hairs absent; thallus composed of creeping, irregular, much-branched filaments growing on or within other algæ; growth principally by division of terminal cells; plastid a parietal band with one or more pyrenoids. Reproduction by 2-ciliate zoospores.

Key.

- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1. Forming a pseudoparenchymatous disc bearing free filaments at the margin. On <i>Flustra</i> , <i>Alcyonidium</i> and <i>Sertularia</i> | <i>E. Flustræ</i> (4). |
| Without a pseudoparenchymatous disc | 2. |
| 2. Several pyrenoids in each cell | <i>E. leptochæte</i> (3). |
| One pyrenoid in each cell | 3. |
| 3. Cells 3–8 μ in diam., 1–6 times as long as broad ... | <i>E. viride</i> (1). |
| Cells 6–9 μ in diam., 7–15 μ long, end cells 26 μ long | <i>E. Wittrockii</i> (2). |

1. ***E. viride*** Lagerh. (*Entocladia viridis* Reinke). Lat. *viridis*, green.—Filaments branching freely, 3–8 μ in diam., cells 1–6 times as long as broad, cylindrical or frequently irregularly swollen and contorted; plastid nearly covering the cell-wall and containing a single pyrenoid.

Within the outer walls of *Derbesia*, *Nitophyllum* and other algæ. Not uncommon; widely distributed.

2. ***E. Wittrockii*** Wille. After V. B. Wittrock, Swedish algologist.—Similar in form to *E. viride*, differing in cell size and habitat. Vegetative cells 7–15 μ by 9 μ , end cells 26 μ by 6 μ .

Within the cell-wall of various brown algæ, particularly *Ectocarpus*; also in species of *Cladophora*. Probably common; Northumberland, N. Wales and S.W. Scotland.

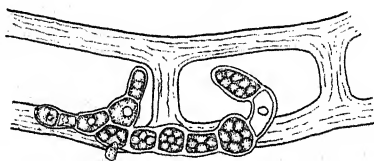


Fig. 48.—*Endoderma leptochæte* Huber. Portion showing zoospores and vegetative cells ($\times 300$).

3. ***E. leptochæte*** Huber. Gr. *leptos*, thin, *chaite*, a hair.—Filaments branching freely, and occasionally bearing colourless hairs; unilateral or appearing dichotomous near the base, 5–15 μ in diam., about 1½ times as long as broad, several pyrenoids in each cell. Zoosporangia formed from vegetative cells; zoospores with two cilia, widely expanded.

In the outer walls of *Ectocarpus penicilliformis*, *Cladophora*, *Ceramium diaphanum*, and other algæ. Rare; Devon.

4. ***E. Flustræ*** Batt. (*Epicladia Flustræ* Reinke).—Cells in the free parts of the filament longer than broad, 5–10 μ in diam.; isodiametric in the pseudoparenchymatous region, 12–20 μ broad.

On *Flustra foliacea*, *Alcyonidium hirsutum*, *Sertularia pumila* and other Polyzoa. Common; England, S. Scotland and Ireland.

var. *Phillipsii* Batt. Cells of free filaments longer and more slender than type; patches extensive and confluent. Rare; Bangor.

9. *TELLAMIA* Batt.

(After R. V. Tellam, British algologist.)

Thallus minute, consisting of radiating, irregularly branched, jointed, creeping filaments, living in the periostracum of mollusca; cells of the filaments often swollen and distorted. Zoospores formed in slightly enlarged cells.

Key.

Filaments interwoven into compact masses, cells 3-10 μ in diam.	<i>T. contorta</i> .
Filaments never interwoven into masses, cells 2.5-4.5 μ in diam.	<i>T. intricata</i> .

T. contorta Batt.—Filaments yellowish green or brown, very irregularly branched, branching both lateral and dorso-ventral; horizontal branches frequently falcate or coiled into a nearly spherical mass, sometimes anastomosing; vertical branches close together, often united laterally, ending in a sharply pointed cell; cells 6-9 μ by 3-10 μ ; enlarged dark-coloured cells 20 μ or more in diam. not infrequent.

On the shells of *Littorina obtusata*. Probably common; widely distributed.

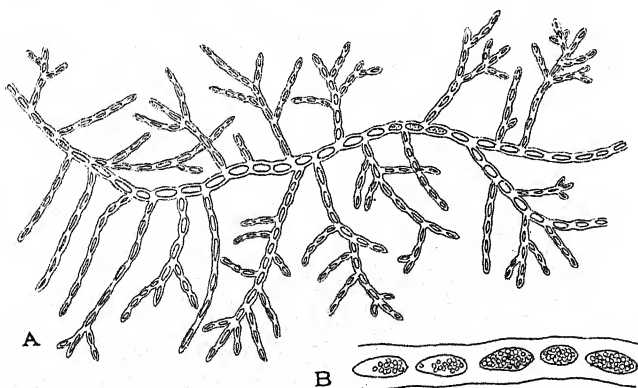


Fig. 49.—*Tellamia intricata* Batt. A. ($\times 300$); B. showing zoospores ($\times 600$).

T. intricata Batt.—Filaments yellowish green, slender; branches long and slender; cells 4-24 μ by 2.5-4.5 μ ; chromatophores parietal, each containing a single pyrenoid.

On the shells of *Littorina obtusata*. Not uncommon; widely distributed.

10. **ULVELLA** Crouan(From its resemblance to *Ulva*.)

Forming small discs on the larger algæ or other objects, attached firmly by the under surface, monostromatic when young, later more than one layer thick, formed of radiating, laterally united, dichotomous filaments; cells multinucleate, with parietal chromatophore and no pyrenoid. Biciliate zoospores formed in the central cells, 4, 8 or 16 in one cell, escaping by an opening at the top.

Key.

- | | |
|--------------------------------------------------------------------------|--------------------------|
| 1. Thallus as much as 75μ thick; on old plants of <i>Fucus</i> | <i>U. fucicola</i> (2). |
| Thallus more than 100μ thick | 2. |
| 2. Cells $3.5-4.5\mu$ in diam. | <i>U. lens</i> (1). |
| Cells $10-12\mu$ in diam.; on old <i>Laminaria</i> stipes | <i>U. confluens</i> (3). |

1. ***U. lens*** Crouan.—Thallus orbicular, $150-250\mu$ thick, as much as 1.5 mm. in diam.; marginal segments more or less cuneate, $15-25\mu$ by $3.5-4.5\mu$; growth terminal, the apical cell forking before dividing.

Epiphytic on other algæ or growing on bits of broken porcelain or glass. Rare; Plymouth Sound.

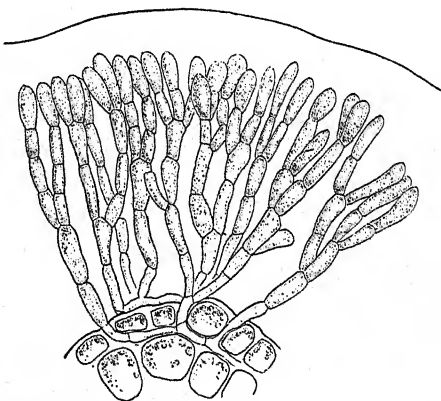


Fig. 50.—*Ulvella fucicola* Rosenv. Long. sect. of thallus ($\times 300$).

2. ***U. fucicola*** Rosenv. *Fucus*, a genus of algæ, Lat. *colo*, I inhabit.—Frond pulvinate or hemispherical, as much as 75μ thick, more or less gelatinous, formed of oblong cells arranged in indistinct radiating series; cells $5-7\mu$ in diam., 3 to 5 times as long as broad, wall not sharply differentiated from the general gelatinous coat; plastid parietal, occupying middle of the cell.

All cells except basal layer forming sporangia; zoospores 6–10 in a sporangium.

On old plants of *Fucus*. Not uncommon; Northumberland and Cheshire.

var. **globosa** Batt. Thicker and more globular than the type. Rare; Berwick.

3. **U. confluens** Rosenv.—Thallus smooth, as much as 250μ thick, formed of more or less regular, closely united vertical filaments, diverging towards the margin; cells $10\text{--}12\mu$ broad, 2–4 times as long as broad, disc-shaped plastid occupying upper part of cell; dissepiments horizontal or oblique, somewhat curved upwards; terminal cells rounded. Sporangia formed from superficial cells; zoospores 30–40 in a cell.

On *Laminaria* stipes. Probably not uncommon; Dorset.

11. PRINGSHEIMIA Reinke

(After N. Pringsheim, German botanist.)

Epiphytic, disc-like thallus, green, with the habit of *Coleochaete scutata*. Reproduction by zoogonidia.

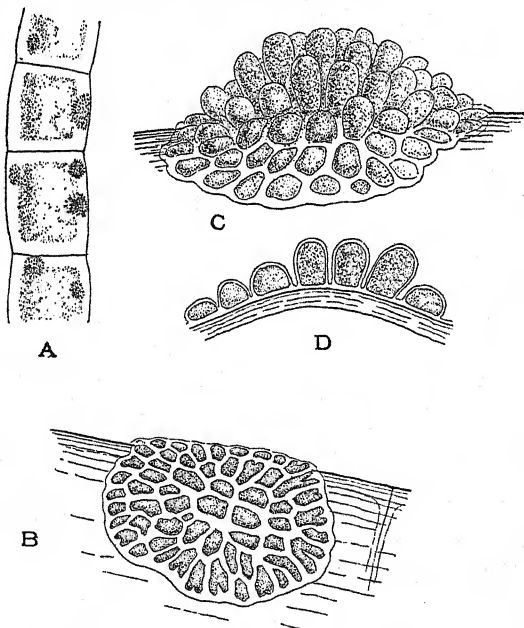


Fig. 51.—*Pringsheimia scutata* Reinke. A. Colonies on host ($\times 35$); B. Single colony ($\times 400$); C. Colony during formation of zoogonidia ($\times 400$); D. Trans. sect. ($\times 400$).

P. scutata Reinke. Lat. *scutatum*, buckler-shaped.—Epiphytic on various algæ, particularly *Ceramium* and *Polysiphonia*.

phonia ; bearing long colourless hairs at certain seasons ; not showing zonate or radiate arrangement.

Rare ; widely distributed.

Order III.—ULVALES

Frond consisting either of one or two cell-layers, a monostromatic tube, or filaments composed of two or more rows of cells ; simple or branched, attached by rhizoids or a disc ; cells containing a single nucleus and parietal plastid with one or more pyrenoids. Vegetative reproduction by abscission of proliferous shoots, by gemmæ or by akinetes ; asexual reproduction by 2- or 4-ciliate zoospores ; sexual reproduction by 2-ciliate gametes forming a zygote capable of immediate germination.

Family I.—ULVACEÆ

Fronds membranaceous, plane or tubular ; cells uninucleate, with disc-like plastids and one pyrenoid. Asexual reproduction by 2- or 4-ciliate zoospores ; sexual reproduction by 2-ciliate gametes.

1. *PROTODERMA* Kütz.

(Gr. *protos*, first, and *derma*, skin.)

Thallus epiphytic, consisting of short procumbent filaments radiating outwards from a pseudoparenchymatous membrane ; plastid with one pyrenoid in each cell. Reproduction by spherical or egg-shaped zoospores, with 2 cilia and 2 contractile vacuoles, 4–18 zoospores formed in each cell ; also by egg-shaped or spherical aplano-spores.

P. marina Reinke.—Forming thin irregular layers composed of angular, parenchymatous cells, 6–12 μ broad, irregularly placed except at the margin where indistinct radiating series occur.

Rare ; Cumbrae.

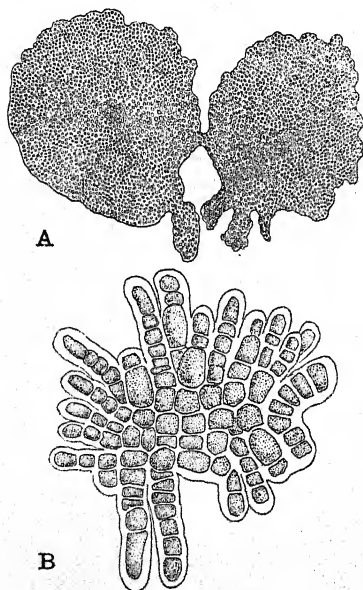


Fig. 52.—*Protoderma marina* Reinke.
A. Thallus ($\times 60$) ; B. Young plant showing radiating cells ($\times 400$).

2. ENTEROMORPHA Link

(Gr. *enteron*, an entrail, and *morphe*, form.)

Frond tubular, slender or inflated, simple or branched, the wall consisting of a single cell-layer. All cells of the membrane, except the very lowest, capable of producing zoospores which are discharged through an opening in the outer wall of the cell.

The separation of the species of *Enteromorpha* presents difficulties on account of the variation in habit due to environmental conditions and the age of the plant. The specific distinctions therefore are not always clearly marked, and perplexing intermediate forms may frequently be found.

Key.

1. Thallus consisting of one or more series of cells,
 - not tubular 2.
 - Thallus tubular 3.
2. Chromatophore filling the cell *E. torta* (4).
- Chromatophore not nearly filling the cell *E. Ralfsii* (3).
3. Cells arranged in longitudinal series only in the
 - youngest parts..... 4.
 - Cells in longitudinal series in the greater part of the frond 8.
4. Thallus with short slender ramuli..... 14.
- Thallus with more or less numerous branches 5.
- Thallus simple or with few branches 6.
5. Branches attenuate at the base and apex *E. lingulata* (8).
- Branches attenuate only at the base *E. compressa* (10).
6. Cells 10-16 μ in diam. ; thallus usually inflated and constricted, often of large size *E. intestinalis* (11).
- Cells 4-8 μ broad, thallus usually only 1-5 cm, long 7.
7. Thallus 8-10 μ thick, membrane equally thickened on both surfaces *E. minima* (13).
- Thallus 15-20 μ thick, membrane with thick inner hyaline layer *E. micrococca*, var. *tortuosa* (12).
8. Thallus simple or with occasional branches, not inflated 9.
- Thallus regularly branched 11.
9. Thallus narrowly linear, strongly compressed... *E. marginata* (5).
- Thallus filiform 10.
10. Thallus, 2-8 cells wide, tubular only in widest parts, branches 2 cells wide *E. torta* (4).
- Thallus, tubular, of uniform diam. *E. prolifer*, var. *tubulosa* (6).
11. Branches proliferous, similar to main filaments *E. prolifera* (6).
- Branches of successive orders gradually smaller, each tapering from base to apex..... 12.
12. Chromatophore filling the cell 13.
- Chromatophore noticeably smaller than the cell lumen..... *E. clathrata* (1).
13. Ultimate ramuli formed of a single cell-series... *E. crinata* (7).
- Ultimate ramuli polysiphonous, formed of a few symmetrically placed cell-series *E. paradoxa* (2).
14. Ramuli attenuate at the base, patent, obtuse *E. usneoides* (14).
- Ramuli attenuate at the apex, spine-like..... *E. ramulosa*, var. *robusta* (9).

1. *E. clathrata* J. G. Agardh. Lat. *clathratus*, latticed.—Fronde filiform, cylindrical or compressed as much as 40 cm. long, much branched in all directions, spine-like branches tapering from base to apex, but not ending in a single series of cells; cells rectangular, usually longer than broad, always in longitudinal series; plastid noticeably smaller than the cell; surface of the frond having a net-like appearance.

Not uncommon; England, Scotland and the Channel Islands.

var. *Linkiana* Batt. (*E. Linkiana* Grev.)—Substance very rigid when dry. Rare, widely distributed.

var. *gracilis* Le Jol.—Branches elongate, silky-white when dry. Rare; Guernsey.

var. *procera* Hauck.—Thallus elongate, 0.5–3 mm. thick, clothed with erect scattered branches which may themselves bear a second series of branches. Torquay.

var. *prostrata* Le Jol.—Thallus repeatedly branched, branches tapering to the apex, forming prostrate woolly mass. Widely distributed.

2. *E. paradoxa* Kütz. (*E. erecta* Hook. and *E. pulcherrima* Holm. & Batt.)—Fronde filiform, cylindrical or compressed, much and repeatedly branched, the branches attenuated to a fine point; ramuli capillary, attenuate upwards, polysiphonous, the cells being symmetrically arranged in successive segments, similar to those of *Polysiphonia*; cells in the main stem and branches in longitudinal and usually in lateral series, plastid filling the cell; bright grass-green, glossy, fragile, adhering to paper.

On rocks in the sea and in tide-pools at about half-tide level. Rare; Devon and Sussex.

var. *tenuissima* Kütz. (*E. Hopkirkii* McCalla.)—Ramuli monosiphonous, cells of adjacent longitudinal series alternating. Not uncommon, widely distributed.

3. *E. Ralfsii* Harv. After J. Ralfs, British algologist.—Fronde tufted, filamentous, very slender, spreading in wide continuous strata over any object which it encounters; each filament simple or rarely having a few short spine-like ramuli scattered here and there; filaments curled or flexuose, sometimes twisted together into bundles, each filament formed of two or four rows of cells; plastids small, not nearly filling the cell.

Forming yellowish-green layers over mud and muddy sand between tide-marks. Rare; Dorset, Devon, Northumberland and N. Wales.

4. *E. torta* Reinb. Lat. *tortus*, twisted.—Fronde decumbent, forming widely spread entangled strata; filaments curled and twisted, simple or with occasional branches; main branches sometimes consisting of a number of cell-rows, more usually of a double row of quadrate cells; plastids filling the cell; bright grass-green, colour well preserved in drying; substance membranaceous, rather soft.

On muddy seashores at half-tide level. Not uncommon; widely distributed.

5. *E. marginata* J. G. Agardh. (*E. canaliculata* Batt.).—Fronde filiform, compressed, simple or with a few short proliferous branches; cells 4–8 μ broad, squarish, arranged in distinct longitudinal series in the lateral rows, less so in the middle portion.

Not uncommon; widely distributed.

Well marked by its slender, nearly simple, canaliculate fronds.

6. *E. prolifera* J. G. Agardh.—Fronde up to several metres long and 2 cm. diam., tubular or compressed, with more or less abundant proliferous branches, which may themselves be simple or proliferous and may vary much in length and diam.; cells 10–12 μ broad, arranged in longitudinal series in the youngest parts, the serial arrangement being somewhat indistinct in the older parts; membrane 15–18 μ thick, not much exceeding the dimensions of the cells in cross-section.

On sticks and stones or floating in quiet waters. Not uncommon; widely distributed.

Differing from *E. intestinalis* Link. and *E. compressa* Grev. in its more proliferous habit and in the longitudinally seriate arrangement of the cells in all but the oldest parts.

var. *tubulosa* Reinb.—Slender, slightly branched, of nearly uniform diam. throughout. Devon and Essex.

7. *E. crinita* J. G. Agardh. Lat. *crinitus*, hairy.—Fronde filiform, compressed or cylindrical, much and repeatedly branched, branches attenuate at the apices, terminating in a single series of short cells; cells usually in longitudinal series, often round, completely or almost completely filled by the chromatophore.

On wood or floating. Rare; Devon, Berwick and near Edinburgh.

Differing from *E. clathrata* J. G. Agardh. in the possession of short-celled monosiphonous ramuli, and from *E. paradoxa* var. *tenuissima* Kütz. in the absence of the net-like appearance caused by the alternating of cells in adjacent series.

8. *E. lingulata* J. G. Agardh. Lat. *lingulatus*, tongue-shaped.—From a few to 30 cm. long; thallus cylindrical, 1–10 mm. broad, attenuate at both ends, lower parts much branched; branches attenuate, elongate, more or less extended, generally naked above, clothed with branchlets below; cells irregularly spherical or 4, 5 or 6 cornered, arranged in longitudinal series in the youngest parts of the thallus.

On *Fucus*. Rare; Torquay and the Orkneys.

9. *E. ramulosa* Hook. var. *robusta* Hauck. Lat. *ramulosus*, much branched.—Fronde tubular, rigid, much-branched, 10–30 cm. long, up to 1 mm. thick; branches curled or twisted, beset with short spine-like ramuli; cells rather rounded, showing

longitudinal series only in the ultimate divisions, chromatophore almost filling the cell. A coarse species, growing on rocks and stones between the tide-marks.

Not uncommon; widely distributed.

var. *tenuis* Hauck.—Thallus lax, almost piliferous. Seilly Islands.

10. *E. compressa* Grev.—Fronde tubular, more or less compressed, sometimes constricted, varying from 2.5 to 30 cm. in length, 0.5 mm. to 1.25 cm. in breadth, simple or branched; branches simple or bearing branchlets, cylindrical or expanding above, attenuate at the base, similar to the main frond; cells in no definite order, except in the youngest parts, 10–15 μ broad; membrane thin.

On rocks, stones and woodwork between tide-marks and in estuaries. Common.

var. *constricta* J. G. Agardh.—Attenuate at the base, wedge-shaped, constricted at intervals or cylindrical and sparsely branched, dilated above. Not uncommon; S. England.

var. *complanata* J. G. Agardh.—Branched at the base, dilated above, apices round. Devon, Cornwall, Northumberland and Scotland.

var. *nana* J. G. Agardh. Tufted, much interwoven, dark green, capillary. Common.

11. *E. intestinalis* Link.—Fronde simple or slightly branched above, often tufted, length varying from a few cms. to several metres, diam. from 1–10 cm.; attached at first by a short cylindrical stipe, later sometimes detached and floating; cylindrical or expanding above, more or less inflated, often much crisped and contorted, irregularly and strongly constricted; cells 10–16 μ broad, in no regular order except in the youngest parts; membrane 20–50 μ thick, usually thickened on the inside, in cross-section cells 12–30 μ in diam.

Attached to various substances between tide-marks, also in brackish ditches. Very common.

var. *flagelliformis* Le Jol.—Elongated, compressed, much branched from the base, branches elongated, apices obtuse. S. England, Orkneys.

var. *bullosa* Le Jol.—Free floating, bladder-like, wrinkled. S. England, Orkneys.

var. *Cornucopiæ* Kütz. (non *E. Cornucopiæ* Carm.).—Thallus 1–6 cm. long, club-shaped, wrinkled. Not uncommon in the N. England and Scotland.

var. *maxima* J. G. Agardh.—Thallus large, up to 4 cm. diam., inflated and bullate, producing small scattered branches. Probably common; S. England, Northumberland.

12. *E. micrococca* Kütz. var. *tortuosa* J. G. Agardh. Gr. *mikros*, small, and *kokkos*, a berry.—Fronde 1–5 cm. long, 1–5 mm. broad, tubular or compressed, simple or sometimes slightly

branched, much curled and twisted; cells not arranged in definite order, angular, $4-5\mu$ broad; membrane $15-20\mu$ thick, with distinct inner hyaline layer.

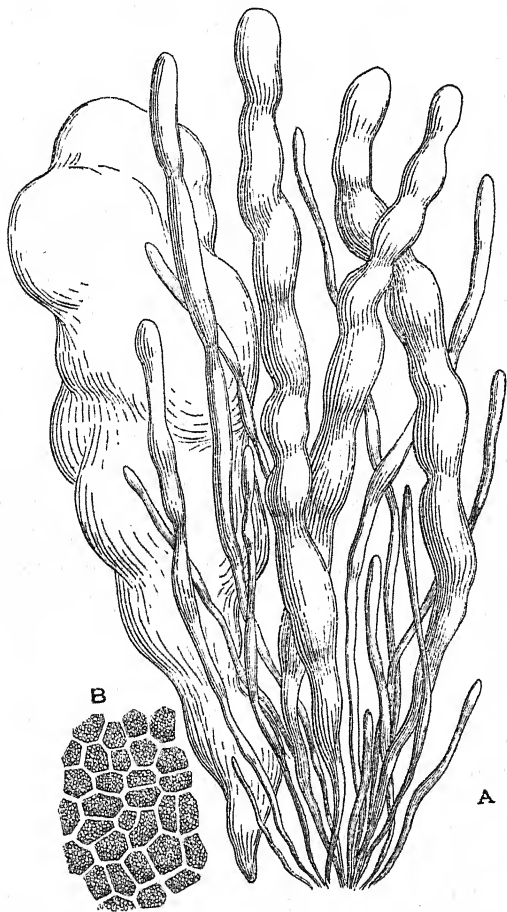


Fig. 53.—*Enteromorpha intestinalis* Link. A. ($\times \frac{3}{4}$); B. Surface view showing zoospores ($\times 280$).

On stones or the vertical sides of cliffs, in the littoral belt. Rare; Kent, Essex and Scotland.

13. *E. minima* Naeg. Lat. *minimus*, smallest.—Frond 1–10 cm. long, 1–5 mm. broad, simple or slightly branched, dilated or collapsing, obtuse at the apex, soft and delicate; membrane $8-10\mu$ thick; cells angular, $5-7\mu$ broad; not arranged

in definite order, membrane equally thickened on both surfaces.

On rocks, timber and on other algæ, near high-water mark.

Softer and more delicate in texture than a small plant of *E. compressa*.

14. *E. usneoides* J. G. Agardh. *Usnea*, a genus of lichens, Gr. *eidos*, like.—From 4–6 cm. long, resembling *Ectocarpus* in habit, or as much as 30 cm. in length, dark green, cylindrical, tubular, branches mostly setaceous; ramuli attenuate at the base, patent, rigid, obtuse; cells rounded or angular, irregularly arranged in the branches, longitudinally seriate in the ramuli, chromatophore filling the cell.

Often on *Fucus vesiculosus*. Rare; widely distributed.

Differing from *E. clathrata* J. G. Agardh. in the chromatophore filling the cell, and from *E. paradoxa* Kütz. in the non-seriate cells of the branches.

3. MONOSTROMA Thur.

(Gr. *monas*, single, and *stroma*, a mattress.)

Frond at first a closed tube or sack, splitting sooner or later into a flattened crisped one-layered membrane except at the base; basal thickening by the formation of elongated rhizoidal cells, forming several layers. Vegetative multiplication by gemmation or proliferation; asexual reproduction by 2- or 4-ciliate zoospores; sexual reproduction by 2-ciliate gametes, originating in unchanged cells.

Key.

1. Frond for a long time saccate, splitting later
more or less to the base *M. Grevillei* (9).
Frond if saccate only so in the early stages 2.
2. Frond dark green, not adhering to paper *M. fuscum* (8).
Frond light green, gelatinous, adhering to paper 3.
3. Mature frond divided into distinct segments ... *M. crepidinum* (7).
Frond broadly lanceolate to orbicular, not split
into segments 4.
4. Thallus more than 30μ thick 5.
Thallus not more than 30μ thick 7.
5. Cells round in surface view *M. laceratum* (3).
Cells angular in surface view 6.
6. Thallus $40\text{--}50\mu$ thick, cells $19\text{--}22\mu$ high in transverse section *M. undulatum* (6).
Thallus $30\text{--}40\mu$ thick, cells $25\text{--}30\mu$ high in transverse section *M. orbiculatum* (5).
7. Thallus over 20μ thick 8.
Thallus $16\text{--}18\mu$ thick *M. Wittrockii* (1).
8. Cells arranged in distinct groups of fours *M. quaternarium* (4).
Cells without definite order *M. latissimum* (2).

1. *M. Wittrockii* Born. After V. B. Wittrock, Swedish algologist.—Thallus bright green, at first very short and saccate, later splitting into an irregular thin membrane, 3–8 cms. broad, 16–18 μ thick; growth marginal; edges of the frond wavy; cells rounded or angular in surface view, arranged more or less in twos or fours; in cross-section appearing round, semicircular, or angular by mutual pressure.

Rare; Devon and S. Scotland.

2. *M. latissimum* Wittr. Lat. *latissimus*, widest.—Attached when young, afterwards floating, irregular, glossy, soft and thin, gelatinous, more or less plicate near the margin; frond 20–25 μ thick; cells round or angular in surface view, closely set, irregularly arranged or very indistinctly grouped in twos, threes or fours; in cross-section vertically oval or nearly circular, 14–18 μ high.

Rare; Devon and Dorset.

3. *M. laceratum* Thur.—Thallus membranaceous, pale green, attached when young, free later, thin and soft, irregular, wrinkled, margin flat or crisped, 40–55 μ thick; cells round in surface view, arranged in twos, threes or fours in a thick gelatinous layer; in transverse section cells oval, upright, 17–23 μ high; young frond cæspitose, obovate-cucullate, later rupturing to form flattened thallus.

Rare; Cornwall, Dorset and Essex.

4. *M. quaternarium* Desmaz. Lat. *quaternarius*, consisting of four.—Frond at first attached, later becoming free, soft and delicate, gelatinous, irregularly lobed and folded, 20–23 μ thick; cells rounded in surface view, when actively growing arranged in threes and fours within the wall of the mother cell; in transverse section semicircular or oval, 15–17 μ high.

Rare; Dorset and Sussex.

5. *M. orbiculatum* Thur. Lat. *orbiculatus*, circular.—Frond membranaceous, attached by rhizoids or later free, suborbicular or irregular in outline, often radially plicate, soft and flaccid, margin undulate; thallus 30–40 μ thick; cells angular, varying in size and arrangement, often irregularly elongate, closely set; vertically oval in transverse section, 25–30 μ high; chromatophore not occupying the whole cell.

Rare; Cornwall and Dorset.

6. *M. undulatum* Wittr.—Frond membranaceous, soft and flaccid, with strongly undulate margin, 40–50 μ thick; cells angular, closely set, showing an indistinct arrangement into twos, threes or fours; in cross-section about 20 μ high, semicircular or oval; chromatophore occupying the centre of the cell, appearing in transverse section as a central band, not more than 10 μ broad.

Rare; Orkney Islands.

7. *M. crepidinum* Farlow. Lat. *crepido*, a causeway.—Frond delicate, light green, 5–15 cm. long, flabellately orbiculate, split

to the base when fully developed, segments obovate, thallus $18-36\mu$ or rarely 45μ thick; cells roundish-angular, when actively dividing forming compact groups of 2, 3 or 4, separated by wide spaces; frond soft, soon collapsing when removed from the water, usually in dense tufts on rocks or woodwork.

Rare; Cornwall and Sussex.

8. *M. fuscum* Wittr. emend. Rosenv. Lat. *fuscus*, dusky.—Frond membranaceous, dark green, tubular when young; soon

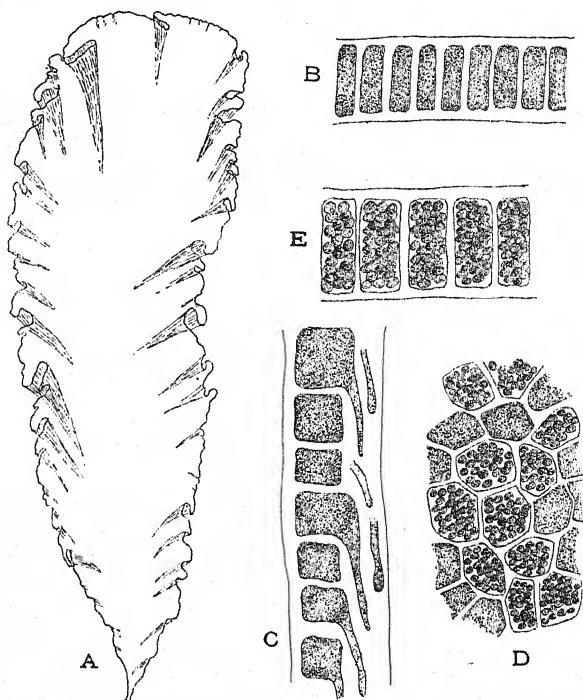


Fig. 54.—*Monostroma fuscum* Wittr. var. *Blyttii* Batt. A. Habit ($\times \frac{2}{3}$); B. Trans. sect. vegetative thallus ($\times 250$); C. Long. sect. ($\times 250$); D. Surface view showing zoospores ($\times 250$); E. Long. sect. showing zoospores ($\times 250$).

splitting into one or more segments, not divided to the base; thallus $20-70\mu$ thick, cells angular, closely set; in cross-section square or vertically elongate with only slightly rounded angles; cells occupying almost the whole thickness of the membrane, not gelatinous.

Not uncommon; N. England and Scotland.

var. *Blyttii* Batt. (*M. Blyttii* Wittr.). After Prof. M. N. Blytt, Norwegian botanist.—Deep green frond, blackish in drying, $60-70\mu$ thick; cells palisade-like in cross-section.

Not uncommon; widely distributed.

9. **M. Grevillei** Wittr. emend. Rosenv. (*Ulva lactuca* Grev.). After R. K. Greville, Scottish cryptogamist.—Frond attached, at first saccate, then splitting to the base, the splitting occurring later in development than in other species, particularly if the frond is growing in still water; thallus soft and delicate, pale green, $15-20\mu$ thick; cells quadrate with rounded angles, closely set; in cross-section horizontally oval, $12-14\mu$ high.

Not uncommon; widely distributed.

var. **VahlII** Rosenv.—Thallus elongate, up to 32 cm. in length. Rare; Northumberland.

var. **arctica** Rosenv.—Thallus $25-45\mu$ thick. Rare; Scotland.

var. **lactuca** Hauck (*M. lactuca* J. G. Agardh).—Thallus $20-28\mu$ thick, 10-30 cm. long. Rare; S. England.

var. **Cornucopiæ** Batt. (*Enteromorpha Cornucopiæ* Carm.).—Markedly stipitate. Rare; widely distributed.

4. CAPSOSIPHON Gobi

(Gr. *kapsa*, a box, and *siphon*, a tube.)

Plants filamentous, hollow, gelatinous; cells arranged usually in twos or fours enclosed within the walls of the mother cells

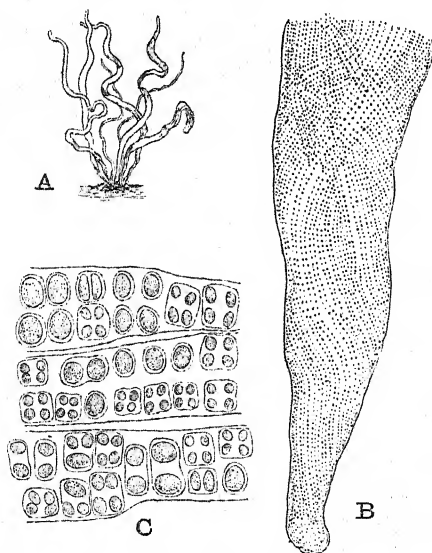


Fig. 55.—*Capsosiphon aureolus* Gobi. A. ($\times \frac{2}{3}$); B. Thallus showing striate appearance ($\times 60$); C. Portion ($\times 400$).

arranged in distinct longitudinal series which may be loosely connected laterally.

1. *C. aureolus* Gobi (*Enteromorpha aureola* Kütz.). Lat. *aureolus*, golden.—Fronds as much as 8 cm. high, filamentous at first, later becoming tubular, up to 2 cm. in diam., cylindrical or compressed, with an occasional swelling, unbranched or slightly branched when older; cells roundish or oval, with thick gelatinous wall, 4–5 μ in diam., arranged in long rows, 2–4 rows being grouped together.

On muddy rocks. Rare; S. Scotland.

5. PERCURSARIA Bory

(Lat. *percursus*, running through.)

Frond slender, at first consisting of a filamentous thread formed from a single series of cells, later becoming two longitudinal rows of cells symmetrically placed throughout or in

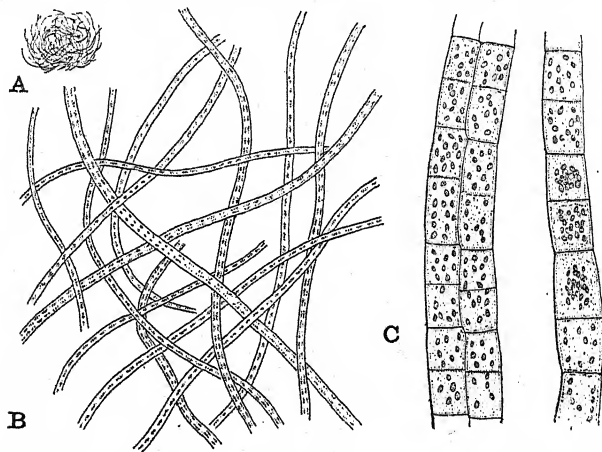


Fig. 56.—*Percursaria percursora* Rosenv. A. ($\times \frac{2}{3}$); B. Filaments ($\times 85$); C. ($\times 400$).

some parts of the filament; cells rectangular, with thick walls and a single chromatophore.

1. *Percursaria percursora* Rosenv. (*Enteromorpha percursora* J. G. Agardh).—Frond several cm. in length, contorted, flexuose, contracted to a single row of cells or expanded to a double row; cells 10–15 μ by 10–30 μ .

Occurring entangled with other filamentous algae in tide-pools. Widely distributed.

6. ULVA, Linn.

(A Latin name for a marsh plant.)

Frond membranaceous, flat, formed of two cell-layers usually closely applied throughout, sometimes separating at the base

and margins; chromatophore parietal; zoospores formed from any cell except those of the thickened or hollow stipe, escaping through an opening on the surface of the frond.

Key.

Frond lanceolate with tubular stipe *U. Linza*.
Frond variously shaped, stipe solid when present... *U. lactuca*.

U. lactuca Linn. var. ***rigida*** Le Jol. (*U. rigida* C. A. Agardh).
Lat. *lactuca*, a lettuce.—Frond at first lanceolate or ovate-lanceolate, firm and stiff; stipe distinct, later irregularly divided,

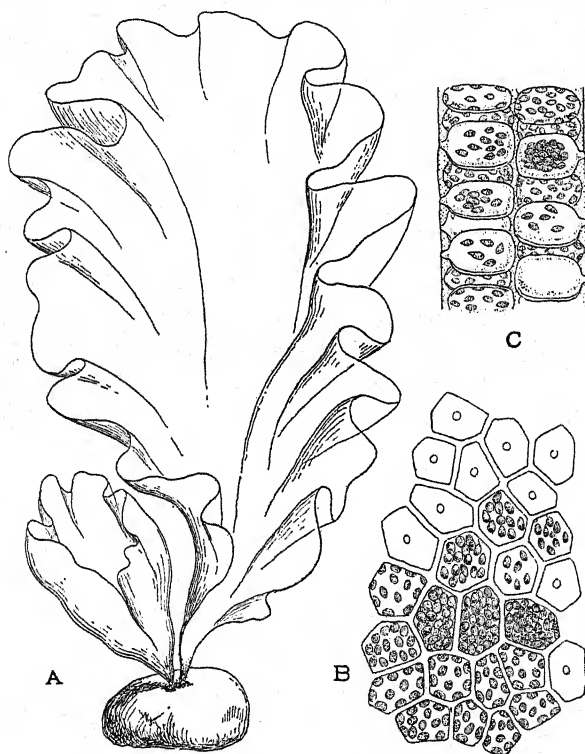


Fig. 57.—*Ulva lactuca* Linn. A. ($\times \frac{3}{8}$); B. Surface view showing zoospores ($\times 420$); C. Longitudinal section ($\times 420$).

often with perforations of various sizes; cells vertically elongate in cross-section as much as three times as long as broad. Green at first, growing deeper with increasing age, finally brownish or blackish.

Rare ; S. England and Channel Islands.

var. *latissima* DC. (*U. latissima* J. G. Agardh).—Fronde irregular in outline, growing in tufts, 15–50 cm. long, margin more or less sinuate and wavy, glossy, translucent, thinner than var. *rigida*, lighter coloured, with cells almost square in transverse cross-section ; not readily adhering to paper. Common.

var. *myriotrema* Born. (*U. myriotrema* Crouan.).—Thallus perforate. Rare ; S. England and Northumberland.

U. Linza J. G. Agardh, var. *lanceolata* Kütz. *Linza*, a name used by Imperator on account of the strap-shape.—Fronde lanceolate or linear-lanceolate, simple, attenuate at the base, slightly tapering at the apex, 10–50 cm. long, 1–20 cm. broad ; stipe short, hollow ; upper part of the frond flat, margins more or less crisped, membranes free at the edges, thallus sometimes saccate when young ; bright grass-green, fading with age ; substance thin, adhering to paper.

In rocky pools between the tide-marks. Not uncommon.

var. *angusta* Kütz.—Narrower than the type. Rare ; Cumbriae.

Order IV.—SCHIZOGONIALES

Thallus filamentous or membranous, deep green ; cells dividing in one, two or three planes. Multiplication by proliferation of the thallus, by akinetes or by aplanospores formed directly from the akinetes.

Family.—SCHIZOGONIACEÆ

Fronde filamentous or membranaceous ; cells with star-shaped plastid and one pyrenoid. Asexual reproduction by akinetes, aplanospores and by segmentation of the frond.

PRASIOLA C. A. Agardh

(Gr. *prasios*, green.)

Thallus filamentous, membranous or foliaceous, monostromatic, procumbent or erect, margins more or less curled ; cells squarish or cylindrical, arranged in fours in some species. Vegetative reproduction by the breaking off of small portions of the frond ; akinetes formed from which aplanospores are developed ; aplanospores rarely formed directly from the thallus cells ; sexual reproduction incompletely known, probably diceious.

Key.

Thallus attached by a stipe or expanded attachment organ	<i>P. stipitata.</i>
Thallus without stipe or disc-like attachment	<i>P. crispa.</i>

P. stipitata Suhr. Lat. *stipitatus*, having a stalk.—Fronde about 0.75 cm. in length, rarely more than 1.25 cm., oval, oblong or wedge-shaped, tapering below into a short stipe; margins more or less curled.

On rocks near high-water mark, forming indefinite patches during spring and early summer. Not uncommon; widely distributed.

The tessellated appearance of the frond under a microscope makes the plant unmistakable.

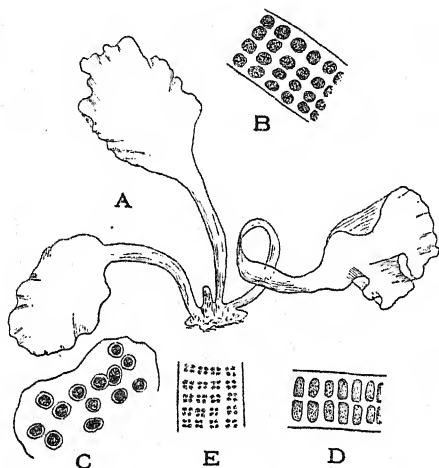


Fig. 58.—*Prasiola stipitata* Suhr. A. ($\times 7$); B. Trans. sect. of thallus of female plant showing cells divided probably prior to sexual reproduction ($\times 270$); C. Surface of female plant with spores ($\times 270$); D. Trans. sect. of thallus of male plant near apex ($\times 270$); E. Trans. sect. of thallus showing divisions to form male gametes ($\times 270$).

P. crispa Meneghini (*Gayella polyrhiza* Rosenv., *Schizogonium disciferum* Holm. & Batt.).—Forming an expanded flattened thallus, free or attached by a few short rhizoids, smooth or vesicular; cells $3\text{--}13\mu$ thick, sometimes filamentous and cylindrical or ribbon-like with cells $7\text{--}14\mu$ thick. Akinetes formed in the thallus, dividing to form aplanospores, giving rise to a new plant.

Order V.—SIPHONOCCLADIALES

Fronds multicellular, usually more or less branched; cells usually multinucleate, rarely uninucleate, plastids net-like or discoid. The term "cell" is here used for a unit within a cell-wall.

Family I.—CLADOPHORACEÆ

Frond of simple or branching monosiphonous filaments, free or more or less united laterally; cells multinucleate, rarely uninucleate, with net-like plastid (or plastid broken into small pieces), pyrenoids present. Asexual reproduction by 4- or 2-ciliate zoospores and by akinetes; sexual reproduction by 2-ciliate gametes.

1. CLADOPHORA Kütz.

(Gr. *klados*, a branch, and *phoreo*, I bear.)

Consisting of branched, articulate, monosiphonous filaments, with terminal or intercalary growth; cells cylindrical or sub-cylindrical, multinucleate, with disc-like parietal plastids; branching lateral, but often appearing dichotomous owing to the pushing aside of the original filament by the branch. Asexual reproduction by 4-ciliate zoospores; sexual reproduction by biciliate gametes, uniting and germinating immediately.

The genus is readily distinguished, but the determination of individual species presents difficulty. Many so-called species are connected by numerous intermediate forms, so that it is doubtful whether they are not environmental forms of the same species; herbarium specimens must be consulted before the species can be determined with certainty.

Subgenus 1.—Eucladophora Farlow

Plants tufted, or at times stratoose, not usually united into spongy masses by rhizoidal branches or re-curved branches; all branches similar, not increasing in size upwards; terminal cell short, adult cells not sub-dividing.

Key.

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| 1. Filaments densely interwoven into a spongy mass, filaments 20–30 μ broad, 4–5 times as long as broad | <i>C. albida</i> (18). |
| Filaments free or slightly interwoven, not spongy | 2. |
| 2. Fronds attached when young, soon detached, floating | 3. |
| Filaments attached throughout active life ... | 4. |
| 3. Main filaments 100–150 μ diam., branches smaller, divaricate; ultimate ramuli secund | <i>C. expansa</i> (21). |
| Main filaments seldom over 100 μ diam., branches of successive orders gradually smaller; ultimate ramuli not markedly secund | <i>C. fracta</i> , var. <i>marina</i> (22). |
| 4. Filaments usually under 120 μ in diam. | 5. |
| Filaments usually over 120 μ in diam. | 15. |
| 5. Fronds soft | 6. |
| Fronds rigid | 10. |
| 6. Cells 20 times as long as broad | 9. |
| Cells shorter | 7. |
| 7. Cells uniformly 3 times as long as broad | <i>C. glaucescens</i> (14). |
| Cells longer | 8. |

8. Branching di-trichotomous, upper ramuli sometimes whorled, fastigiate at the tips of the branches, sometimes alternately secund *C. sericea* (13).
Branching alternate or secund, rarely opposite *C. trichocoma* (11).
9. Branching alternate with small angles *C. Balliana* (19).
Branching alternate or opposite, angles wide, main divisions angularly bent *C. Rudolphiana* (20).
10. Filaments about 6 cm. long or less, rigid 11.
Fronds freely branched 12.
11. Branches irregularly dichotomous, or angularly alternate *C. Magdaleneæ* (23.)
Branches corymbose *C. corymbifera* (17.)
12. Branches arching or strongly hooked inwards... *C. falcata* (4).
Not so 13.
13. Branches and ramuli reflexed 14.
Branches regularly flexuose throughout the frond *C. flexuosa* (15).
14. Apices blunt, rounded..... *C. Macallana* (5).
Apices markedly attenuate *C. refracta* (16).
15. Filaments rigid..... 16.
Filaments not rigid 20.
16. Filaments dark green 17.
Filaments lighter in colour..... 19.
17. Branches opposite, widespreading, often arising from one main axis; ramuli short, distichous, horizontal *C. rectangularis* (6).
Not so 18.
18. Filaments 150–200 μ in diam. *C. Neesiorum* var. *humilis* (7).
Filaments 80–150 μ in diam. *C. rupestris*. (8).
19. Branching di-, tri- or polychotomous, branches arising from every cell *C. pellucida* (2).
Branching chiefly alternate, more than one cell between the branches..... *C. utriculosa* (10).
20. Filaments 300–400 μ in diam.; ramuli blunt ... *C. prolifera* (1).
Filaments less than 300 μ in diam. 21.
21. Filaments 100–250 μ in diam.; ultimate ramuli stout, blunt, constricted at the nodes *C. Hutchinsiae* (3).
Filaments 40–150 μ in diam.; ultimate ramuli slender, not constricted at the nodes 22.
22. Filaments with comparatively few main branches, beset throughout with short, patent, often secund ramuli *C. hirta* (9).
Filaments much branched, branches of successive orders decreasing in size, tips clothed with series of secund patent ramuli *C. gracilis* (12).

1. **C. prolifera** Kütz. Lat. *proliferus*, bearing progeny as offshoots.—Dense, dark green, as much as 20 cm. long; filaments coarsely membranaceous or cartilaginous, 300–400 μ in diam., divisions mostly erect, di-trichotomous, tips somewhat fastigiate; ramuli blunt, 130–200 μ broad; cells up to 20 times as long as broad in the main filaments, much shorter in the branches, 4–6 times as long as broad in the ramuli.

In the lower littoral zone and in shallow water. Rare; Dorset.

2. **C. pellucida** Kütz. Lat. *pellucidus*, transparent.—Tufts 4–15 cm. long; filaments rigid and erect, 350–500 μ in diam.

in the main axes, 150–250 μ in the branches; branching usually regularly di-trichotomous (here and there polychotomous), branches arising at each articulation, or the main branches di-trichotomous with two or more branchlets arising at each articulation; youngest branches unilateral; upper articulations 6–8 times, the lower 16 or more times, as long as broad. Long branched rhizoids arising from the basal articulation.

Not uncommon in England and Ireland, very rare in Scotland.

var. *comosa* Kütz.—Branches terminating in dense masses of attenuate hairs. Wales.

var. *cristata* Kütz.—Bearing tufts of short terminal ramuli. Ireland, S. England.

var. *curvata* Kütz.—Terminal ramuli sickle-shaped. Isle of Man.

3. *C. Hutchinsiae* Harv. After Miss Hutchins, Irish botanist.—As much as 40 cm. long, glaucous green; filaments stiff, flexuose, sparingly branched, 120–300 μ in diam.; ultimate ramuli few, secund, blunt, constricted at the nodes, articulations 2–3 times as long as broad.

Not uncommon in England and Ireland; rare in Scotland.

var. *distans* Kütz. (*C. diffusa* Harv.).—More slender than the type, substance less rigid.

Not uncommon; widely distributed.

4. *C. falcata* Harv. Lat. *falcatus*, hooked.—Densely tufted, dark green, sometimes interwoven and entangled at the base, 7.5 to 10 cm. long; filaments 60 μ broad, nearly of equal diameter throughout, much branched; branches curved and twisted, or curled in various directions; lesser branches alternate, secund, or two or three springing from the same point, all very erect, arching or strongly hooked inwards, furnished on their concave side with numerous secund ramuli of unequal length, the longer bearing a second series of hooked unilateral branchlets; articulations 3 or 4 times as long as broad; substance rigid and crisp.

Very rare; Devon, Ireland and Channel Islands.

5. *C. Macallana* Harv. After W. McCalla, Irish algologist.—Forming crisped sub-cylindrical bundles 15–50 cm. long, bristling (not collapsing) when removed from the water, grass-green, much branched and inextricably tangled, rather brittle; cells as much as 170 μ broad in the lower parts, 4–5 times as long as broad; 90–105 μ broad in the upper parts, 2–4 times their breadth; branches flexuose or zigzag, opposite, alternate or secund; sometimes subdichotomous, very patent, with wide axils; furnished with a second and third series of smaller branches, clothed at intervals with short ramuli; ramuli alternate or secund, very patent or reflexed, short, cylindrical, obtuse, simple or branched, apices blunt; adhering imperfectly to paper.

Rare; Roundstone Bay, Galway.

6. *C. rectangularis* Harv.—Densely tufted, 20–30 cm. long, divided irregularly into 3 or 4 principal branches or with an undivided stem; branches very patent, issuing nearly at right angles, distant, opposite, occasionally alternate, 200–300 μ in diam.; simple or with a second series of similar branches, mostly furnished throughout with short, opposite, horizontal, simple ramuli, 150–200 μ broad, which may be ternate or quaternate; articulations 2 or 3 times as long as broad; bright green; substance crisp and rather rigid, soon becoming flaccid on removal from the water, never adhering to paper.

Very rare in England, but locally abundant on the west coast of Ireland.

var. *subnuda* Kütz.—Lateral ramuli few in number or absent. Devon.

var. *horrida* Kütz. (*Conferva Crouani* Chauv.).—Rigid, lateral ramuli sub-second, single, rarely opposite. W. coast of Ireland and S.W. Scotland.

var. *hispida* Kütz.—Elongated, lateral ramuli verticillate. Devon and N. Ireland.

7. *C. Neesiorum* Kütz. var. *humilis* Batt. (*C. humilis* Kütz.). After C. G. D. and T. F. L. Nees von Esenbeck, German botanists.—Densely tufted, 2–8 cm. long, rigid, dark or olive-green; filaments repeatedly branched from the base, 150–200 μ in diam.; branches densely packed, ramuli short, 80–150 μ in diam.; articulations $1\frac{1}{4}$ –4 times as long as broad.

Probably not uncommon; S. England, Northumberland and Cumbrae.

8. *C. rupestris* Kütz. Lat. *rupestris*, growing among rocks.—Filaments dark green, 80–150 μ broad; fronds densely tufted, much branched, the branches opposite or in fours, erect; ultimate ramuli short, blunt or slightly subulate; articulations 3–4 times as long as broad.

On rocks between the tide-marks and in deep water. Common and abundant all the year round.

var. *distorta* Harv.—Filaments short, much curled and matted together. On submarine peat at Birturbui Bay, Connemara.

var. *nuda* Holm. & Batt. (*C. nuda* Harv.).—Articulations many times longer than broad; ramuli few and scattered. Port Stewart, Co. Antrim.

9. *C. hirta* Kütz. (*Conferva flexuosa* Dillw.). Lat. *hirtus*, shaggy.—Filaments rather stiff, 50–200 μ broad, more or less bent and branched, beset almost throughout with short, usually second, subacute ramuli; articulations 2–4 (rarely 6) times as long as broad.

Not uncommon; S. England and Berwick.

10. *C. utriculosa* Kütz. (*C. latevirens* Harv. p.p.). Lat. *utriculosus*, inflated.—Tufted, light or dull green, 10–20 cm. long; filaments firm, sub-membranaceous, di-polychotomous,

100–250 μ in diam. near the base, 70–100 μ in the upper parts, which are set with lateral, often secund ramuli; cells 6–8 times as long as broad below, 2–4 times above.

Not uncommon; widely distributed.

var. *diffusa* Hauck. Branches secund, clothed with secund unilateral ramuli. Sussex and Norfolk.

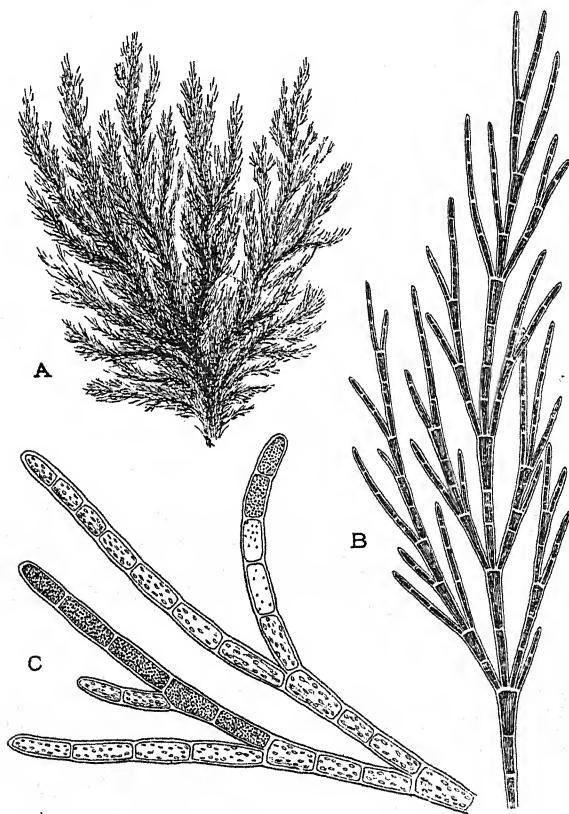


Fig. 59.—*Cladophora rupestris* Kütz. A. ($\times \frac{1}{4}$); B. Portion ($\times 25$); C. Fertile branch ($\times 50$).

11. *C. trichocoma* Kütz. (*C. nitida* Kütz.). Gr. *trichoma*, a growth of hair.—Dense, yellowish or whitish-green, somewhat mucilaginous, soft, 10 cm. or more long; main filaments 50–100 μ in diam., bearing more or less frequent straight, virgate branches, with alternate or secund, rarely opposite, erect branches of higher orders and secund slender ramuli, 20–30 μ in diam.;

cells cylindrical, 4–12 times as long as broad (usually more than 6 times).

Rare ; Sussex, Scotland and Ireland.

12. *C. gracilis* Kütz. Lat. *gracilis*, slender.—Loosely tufted, 7.5–30 cm. long, irregularly bent, with short pectinate branches and recurved or incurved unilateral branchlets at the angles ; yellowish-green ; cells 100–140 μ in diam. in the main branches, 20–50 μ in the ramuli, 2–6 times as long as broad, somewhat constricted at the nodes ; substance soft and pliant, not gelatinous.

Not common ; widely distributed.

var. *tenuis* Thur.—Branches remote, filaments more slender than the type. Rare ; Dorset.

13. *C. sericea* Kütz. (*Conferva latevirens* Dillw. and *Cladophora crystallina* Kütz.). Lat. *sericeus*, of silk.—Soft, glossy, yellowish or whitish green, 10–30 cm. high ; filaments somewhat matted, distantly di-trichotomously branched, main branches 80–140 μ in diam., ramuli 25–40 μ ; branching erect or patent ; upper ramuli sometimes whorled, fastigate at the tips of the branches, sometimes alternately secund ; cells cylindrical, 4–12 times as long as broad.

Common ; widely distributed.

14. *C. glaucescens* Harv. Lat. *glaucescens*, becoming sea-green.—Loosely tufted, 10–40 cm. long, glaucous or yellowish-green ; much branched, ultimate ramuli long, erect, acute, sometimes secund ; filaments delicate, 30–60 μ in diam., 3 times as long as broad ; membranaceous, rather soft, but not flaccid, adhering to paper imperfectly.

Not uncommon ; widely distributed.

15. *C. flexuosa* Harv.—Light green, 10–20 cm. long ; main filaments 80–120 μ in diam. ; branches 40–80 μ , regularly flexuose, bearing alternate or secund, curved and sometimes refracted ramuli ; articulations up to 6 times as long as broad in the main axes, 2–3 times their breadth in the ramuli.

Not uncommon ; widely distributed.

Distinguished from *C. glaucescens* by its firmer texture, less luxuriant branching, curved ramuli, and uniformly flexuose filaments.

16. *C. refracta* Aresch. Lat. *refractus*, broken.—Filaments stiff, glaucous green, 40–120 μ in diam. ; articulations 2–3 times as long as broad ; branches flexuose, the secondary branches and branchlets erect at first, then reflexed, upper faces pectinate ; ultimate ramuli often secund, blunt at the apices.

Probably not uncommon ; widely distributed.

17. *C. corymbifera* Kütz. Lat. *corymbus*, a cluster of flowers, *fero*, I bear.—Small, densely branched, rigid, dark green ; ramuli erect, stiff ; lower branches 75 μ broad, upper corymbose, 45 μ broad ; cells twice as long as broad in the older parts, equal or twice as long as broad in the younger.

Rare ; Hants and Northumberland.

18. *C. albida* Kütz. Lat. *albidus*, whitish.—Soft, dense, pale green; filaments 15–30 cm. long, 20–30 μ in diam.; branching irregular, penultimate ramuli long, patent, blunt, usually opposite, the ultimate ramuli generally short and secund; cells 4–5 times as long as broad, cylindrical; flaccid, adhering to paper.

Not uncommon; widely distributed.

var. *refracta* Thur. (*Conserva refracta* Wyatt, *Cladophora refracta* Harv. p.p., *C. curvula* Kütz.).—Like the type, but with recurved branches in the upper part of the frond, set with recurved ramuli.

Not uncommon; widely distributed.

19. *C. Balliana* Harv. After Miss A. E. Ball, Irish algologist.—Grass-green, 15–20 or even 25 cm. long; tufted and much branched, the branching repeatedly alternate but very irregular, with a more or less evident leading axis; lesser branches 2.5–5 cms. long, somewhat virgate, undivided, set with minor branches bearing short pectinate ramuli along their inner faces; ramuli very slender, usually 2–3 cells long, branches and ramuli attenuate at the apex; cells 8–10 times as long as broad in the branches, shorter in the ramuli; soft and tender, adhering to paper.

Rare; E. Ireland, S.W. Scotland and Puffin Island.

20. *C. Rudolphiana* Harv. After F. C. L. Rudolphi, Italian botanist.—Filaments 15–50 cm. long, much branched, bright yellowish-green, inextricably tangled, gelatinous, branches often opposite, patent, flexuose, ultimate ramuli secund, subpectinate, attenuate at the apices; Cells 20–60 μ in diam., as much as 20 times as long as broad in the branches, 6–10 times in the ramuli; very soft, closely adhering to paper.

On *Zostera*, *Laminaria* and other algæ. Abundant at Roundstone Bay, Connemara; very rare elsewhere.

Distinguished from *C. gracilis* by its slender filaments, softer and more flaccid substance and longer cells, and from *C. albida* by the greater length of the cells.

21. *C. expansa* Kütz.—Dull green, loosely branched, the main branches 100–150 μ in diam., flexuose, with smaller, patent, secondary branches, divaricately divided; ultimate ramuli 40 μ broad, secund, blunt; cells 3–6 times as long as broad; at first attached, but soon loosened and floating.

Rare; Dorset and Norfolk.

22. *C. fracta* Kütz. var. *marina* Hauck. Lat. *fractus*, feeble.—Tufts irregular, dull green; filaments somewhat stiff, 80–120 μ in diam., sparingly and somewhat dichotomously divided; branches spreading, angularly bent, with few and irregular blunt ramuli; cells 3–6 times as long as broad; at first attached, soon becoming loosened.

Common; widely distributed.

var. *flavescens* Batt. (*C. flavescens* Harv., non Kütz.).—Filaments 30–60 μ in diam.; cells 6–10 times as broad, ultimate ramuli tapering but with blunt tips.

Not uncommon; widely distributed.

var. *flexuosa* Batt. (*Conferva flexuosa* Batt.).—Filaments flexuose, ramuli short, simple, spreading.

Rare; Norfolk.

23. *C. Magdalene* Harv. After Miss Magdalen Turner, British algologist.—Fronds short, coarse, dull green, matted, procumbent, with patent flexuose branches bearing a few irregularly arranged, curving ramuli; filaments 60–100 μ broad, cells 2–4 times as long as broad, blunt at their apices; substance rigid, not adhering to paper.

Rare; S. England and Channel Islands.

Subgenus 2.—*Ægagropila* Kütz.

Plants forming thickened cushion-like or rounded tufts.

Key.

- | | |
|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1. Cells as much as 20 times as long as broad, cylindrical, not attenuate at the apices | <i>C. repens</i> (1). |
| Cells less than 20 times as long as broad | 2. |
| 2. Branches opposite or subverticillate, reflexed, ramuli 2–3 cells long, reflexed, cells 4–8 times as long as broad | <i>C. cornea</i> var. <i>verticillata</i> (3). |
| Branches not opposite or subverticillate | 3. |
| 3. Lower cells markedly clavate, upper cylindrical. Exposed to alternate influence of salt and fresh water | <i>C. Brownii</i> (2). |
| Cells cylindrical, apical cells bluntly pointed. Usually among roots of <i>Zostera</i> | <i>C. corymarthra</i> var. <i>spinescens</i> (4). |

1. *C. repens* Kütz. Lat. *repens*, creeping.—Tufts very dense, 2.5–5 cm. broad, about 1.25 cm. thick, globose or oblong, cushion-like, formed of numerous filaments matted together; filaments at first decumbent, attached by numerous rhizoids; later erect branches arise, simple or once forked, naked or furnished with a few simple, secund ramuli; cells as much as 20 times as long as broad, cylindrical, not attenuate at the apices of the branches; substance rigid, not adhering to paper.

Very rare; Dorset, Northumberland and Channel Islands.

2. *C. Brownii* Harv. After Robert Brown, British botanist.—Tufts very dense, cushion-like, spreading over the rocks in patches of indefinite extent, from 1.25–2.5 cm. deep in the middle, gradually thinner towards the edges, blackish-green; filaments densely matted, rigid, erect; branches long, simple, secund or sub-dichotomous; articulations 4 or 5 times longer

than broad, the lower ones markedly clavate, the upper cylindrical.

In maritime situations exposed to the alternate influence of salt and fresh water. Very rare; Cornwall and Ireland.

3. *C. cornea* Kütz. var. *verticillata* Kütz. (*C. retroflexa* Crouan). Lat. *corneus*, horny.—Small tufts, 1–2 cm. broad, much branched, branches opposite or sub-verticillate, reflexed; ramuli 2 or 3 cells long, also reflexed; cells clavate, 4–8 times longer than broad.

On the rhizomes of *Zostera*. Very rare; Dorset and Ireland.

4. *C. corynarthra* Kütz. var. *spinescens* Batt. Gr. *korune*, a club, *arthron*, a joint.—Filaments densely packed together, forming a dark green, spongy, thorny layer, 2.5–7.5 cm. broad; branches numerous, stiff, irregularly placed; branchlets opposite, dichotomous or 3 or more in a whorl, main branches secund, bluntly pointed; cells 40–120 μ in diam., 2–5 times longer than broad.

Among the roots of *Zostera*, among stones and damp soil near high-water mark. Rare; S. England and Ireland.

Subgenus 3.—*Spongomorpha* Kütz.

Plants spongy, at least near the base, owing to the interlacing of the branches, many of which are reflexed and rhizoidal; fronds with normal erect filaments, increasing in diameter upwards; terminal cells long, from which cells are successively cut off below.

Key.

- | | |
|-----------------------------------------------------------------------------------------------------|----------------------------|
| 1. Forming indefinite cushion-like patches similar to <i>Vaucheria</i> , near high-water mark | <i>C. arctiuscula</i> (4). |
| Tufted | 2. |
| 2. Bearing rhizoids, each with a plate of cells at the distal end | <i>C. stolonifera</i> (5). |
| Without rhizoids | 3. |
| 3. Filaments more than 50 μ broad | 4. |
| Filaments 20–40 μ broad | 6. |
| 4. Main axes distinct, clothed with opposite or scattered ramuli, cells 110 μ broad | <i>C. Traillii</i> (2). |
| Main axes indistinct | 5. |
| 5. Cells 4–6 times as long as broad at the tips of the branches, 1½–3 times their breadth below | <i>C. arcta</i> (1). |
| Cells once or twice as long as broad | <i>C. Sonderi</i> (3). |
| 6. Cells 2–6 times as long as broad, light green ... | <i>C. lanosa</i> (8). |
| Cells equal in length and breadth or as much as 2.5 times as long as broad | 7. |
| 7. Plant 2–4 cms. long, branches 20 μ broad, whitish-green | <i>C. pallida</i> (6). |
| Plant 5–6 cms. long, branches 28 μ broad, pale olive-green | <i>C. bombycina</i> (7). |

1. *C. arcta* Kütz.—Deep green, in dense tufts, fastigiate, filaments 60–100 μ broad; cells 4–6 times as long as broad at

the tips of the branches, $1\frac{1}{2}$ –3 times their breadth in other parts; filaments erect, rigid, much branched, branches erect or depressed, obtuse or clavate, giving off descending rhizoid-like branches, 40 – 60μ broad, by which the lower part of the tuft is firmly matted together.

On rocks from half-tide level to low-water mark. Not uncommon; widely distributed.

2. *C. Traillii* Batt. (*Acrosiphonia Traillii* Batt.). After G. W. Traill, Scottish botanist.—Filaments slender, 2.5 – 5 cm. long, tufted, densely matted at the base, free and divergent above; dark green, soon becoming brownish-olive; tufts composed of numerous separate bundles of filaments; branches near the base rhizoidal, recurved and interlaced; upper branches erect, opposite or sub-secund; main axis distinct, composed of 1 or 2 long branches, beset with opposite or scattered ramuli; ultimate branches of 2 kinds, the one having apices drawn out with a long slender point, the other of nearly equal diameter throughout, with very obtuse apices; hooked branches present in small numbers; average width of filaments 110μ . Fertile cells 1 – $2\frac{1}{2}$ times as long as broad.

On rocks in shallow tide-pools, in the shade, a little above half-tide level. Very rare; near Edinburgh.

3. *C. Sonderi* Kütz. After W. Sonder, German algologist.—Forming thick dark green tufts, 5 – 8 cm. long; filaments rigid, erect, attached at the base by numerous rhizoids, 80 – 150μ thick, much branched; branches of first and second order variable in form, often unilateral, upper parts sometimes very densely branched; cells once or twice as long as broad.

Very rare; Dorset and Orkney Islands.

4. *C. arctiuscula* Kütz.—Forming indefinite cushion-like patches over muddy sand-covered rocks near high-water mark, very similar to *Vaucheria*.

Possibly only a form of *C. arcta*.

5. *C. stolonifera* Batt. (*Acrosiphonia stolonifera* Kjellm.). Lat. *stolo*, a shoot, *fero*, I bear.—Epiphytic, tufted, about 2 – 3 cm. long, bearing rhizoids each with a plate of cells at the distal end; yellowish-green, paler at the base; main branches 25μ broad, division intercalary, cells varying in length, branches sub-corymbose; ramuli scattered or unilateral, erect and adpressed or patent. Fertile cells intercalary, 2 or more in a row, varying from twice as long as broad to shorter than their diameter.

Rare; Berwick and Cumbræ.

6. *C. pallida* Batt. (*A. pallida* Kjellm.). Lat. *pallidus*, pale.—Basal layer present, plant tufted, 2 – 4 cm. long, sub-globose; branches densely interwoven into sub-clavate masses, pale greenish white; main branches 20μ broad, division intercalary; cells equal in length and breadth or twice as long as broad;

ramuli sometimes opposite, more frequently irregular below, unilateral above. Fertile cells in the branches, occurring in pairs or in chains, rarely shorter than their diam., usually equal in length and breadth or $1\frac{1}{2}$ times as long as broad.

Rare; Berwick and Cumbrae.

7. *C. bombycina* Batt. (*Acrosiphonia bombycina* Kjellm.; *C. lanosa* Harv. p.p.) Lat. *bombycinus*, silky.—Basal layer present; thallus epiphytic, densely tufted, more or less matted below, elongate and attenuate above, very flaccid and loosely interwoven, 5–6 cms. long, pale olive-green; main branches 28μ broad, division intercalary; cells equal in length and breadth or 2.5 times as long as broad; branches and ramuli divaricate or erect. Fertile cells equal in length and breadth or twice as long as broad, borne in the branches.

Not uncommon; widely distributed.

8. *C. lanosa* Kütz. Lat. *lanosus*, woolly.—Tufted, light green, filaments $30\text{--}40\mu$ broad; cells 2–6 times as long as broad; fronds fastigate; branches erect, blunt, more or less matted at the base by numerous rhizoidal filaments, slightly narrower than the erect filaments.

Epiphytic on various algæ. Not uncommon; widely distributed.

var. *uncialis* Thur. (*C. uncialis* Kütz., including *C. congregata* Kütz.).—Tufts irregular, not fastigate except in early stages.

On rocks. Not uncommon; widely distributed.

The fronds do not become detached, floating away like pale green tassels, as in the type.

var. *Zosteræ* Dillw.—Glossy, grass-green, on *Zostera*. Rather rare; Dorset, Sussex and Scotland.

2. CHÆTOMORPHA Kütz.

(Gr. *chaite*, a bristle, and *morphe*, form.)

Filaments composed of single series of multinucleate cells, all capable of reproduction and division except a few basal cells; attached by more or less branched rhizoids, often coalescing; plants sometimes free floating when old; cell wall thick, firm, often distinctly lamellate; chromatophore a parietal band, more or less perforate, or broken into small discs in age; pyrenoids numerous. Reproduction by 4-ciliate zoospores and 2-ciliate isogametes; thick-walled akinetes also formed from single cells.

TORTUOSÆ.

Filaments twisted together forming intricate masses, resting on stones or other algæ, not attached.

Key.

- | | |
|------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 1. Cells 300–700 μ in diam..... | 2. |
| Cells less than 300 μ in diam. | 3. |
| 2. Cells not more than 300 μ in diam., 1 or 1½ times
as long as broad; closely entangled | <i>C. linum</i> (3). |
| Cells 300–700 μ in diam., as long as broad; harsh,
loosely entangled filaments | <i>C. crassa</i> (4). |
| 3. Cells 100–300 μ in diam., 1 or 1½ times as long
as broad; closely packed strata..... | <i>C. linum</i> (3). |
| Cells 45–150 μ in diam., as long as broad or
shorter; loosely entangled strata | <i>C. litorea</i> (2). |
| Cells 40–100 μ in diam., 2–3 times as long as
broad; curled and twisted filaments, loose
woolly masses | <i>C. tortuosa</i> (1). |

1. *C. tortuosa* Kütz. (*Conferva tortuosa* Dillw.)—Filaments rigid, slender, much curled and twisted, forming broad closely interwoven strata; cells 2 or 3 times as long as broad, 40–100 μ in diam.; bright green, glossy.

Forming woolly strata on other algæ or more rarely on the rocks. Not uncommon; widely distributed.

2. *C. litorea* Cooke (*Conferva litorea* Harv., *C. chlorotica* Kütz.). Lat. *litoreus*, living on the shore.—Filaments unattached, except possibly in the early stage, entangled, soft and rather delicate, light green, 45–150 μ in diam.; filaments of the same mass variable in width; cells 1½ to twice as long as broad, uniformly 500–600 μ long.

In salt-water ditches, estuaries and muddy seashores between the tide-marks. Rare; widely distributed.

3. *C. linum* Kütz. (*Conferva sutoria* Berk.). Lat. *linum*, flax.—Filaments setaceous, extremely long, flexuose, dark green; cells 1 or 1½ times as long as broad, 100–300 μ in diam.; substance rigid, not adhering to paper.

Not uncommon; widely distributed.

Near *C. crassa* Kütz., differing by its slenderer habit, and longer cells.

4. *C. crassa* Kütz. (*Conferva linum* Harv. non alior.)—Filaments thick, of great length, light or dark green according to age, much curled, rigid, forming loosely entangled harsh strata; cells about as long as broad, 300–700 μ in diam., substance rigid-membranous, scarcely adhering to paper.

In salt-water ditches near the coast. Rare.

A coarse species forming readily separable layers often several yards in circumference.

STRICTÆ.

Filaments arising in tufts from a definite base.

Key.

- More or less flaccid, dark green, occurring in tufts,
attenuate at the base *C. ærea*.
Stiff rigid habit, glaucous green, not attenuate at
the base *C. melagonium*.

C. ærea Kütz. (*Conferva ærea* Dillw. and *Chætomorpha baltica* Kütz.). Lat. *æreus*, airy.—Filaments erect, dark green, becoming yellowish with age, almost cylindrical throughout, slightly attenuate at the base, attached by rhizoids developed from the basal cells, later coalescent into a disc; cells at first

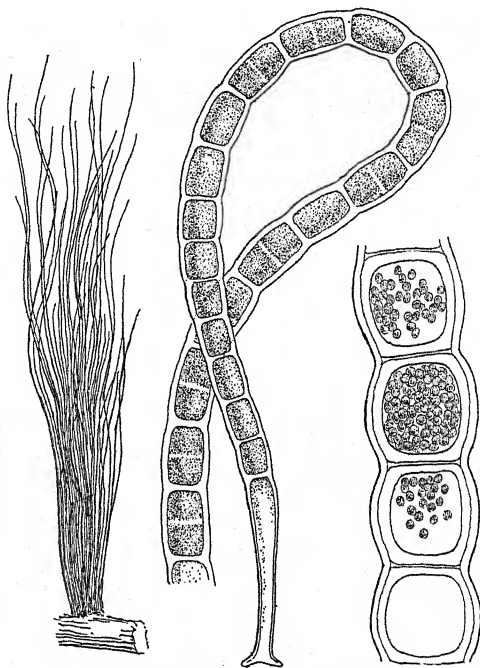


Fig. 60.—*Chætomorpha ærea* Kütz.

cylindrical, half to twice as long as broad, longer near the base, almost spherical when fertile; wall hyaline, thick, sometimes lamellate; plastid, at first continuous, finely fenestrate.

In shallow sandy pools near high-water mark. Not uncommon; widely distributed.

C. melagonium Kütz. (*Conferva melagonium* Web. & Mohr, var. *rupicola* Aresch.). Gr. *melas*, black, *gone*, progeny.—Filaments caespitose or scattered, attached by short stout

rhizoids ; erect, coarse, stiff, dark glaucous green, 20–60 cm. long ; cells 300–700 μ in diam., once or twice as long as broad, basal cells slightly attenuate below, elongate.

Widely distributed ; never very abundant.

3. RHIZOCLONTIUM Kütz.

(Gr. *rhiza*, a root, and *klonion*, a branch.)

Filaments mainly prostrate, formed of a unicellular filament, unbranched or slightly branched, bearing few to many rhizoidal branchlets ; cells usually multinucleate, with a single reticulate parietal plastid with numerous pyrenoids. Reproduction by fragmentation, by akinetes and by 2-ciliate zoospores.

Distinguished from *Chaetomorpha* by the presence of rhizoidal branchlets, cylindrical (never swollen) cells, and tendency to a horizontal habit.

Key.

- | | |
|------------------------------------------------------------------------------------|--------------------------|
| 1. Filaments flaccid or lubricous | 2. |
| Filaments rigid | <i>R. arenosum</i> (3). |
| 2. Rhizoidal branches frequent, often 2 or 3 cells long | <i>R. riparium</i> (4). |
| Rhizoidal branches scarce, unicellular when present | 3. |
| 3. Cells 10–14 μ broad, $3\frac{1}{2}$ –4 $\frac{1}{2}$ times as long as broad | <i>R. Kochianum</i> (1). |
| Cells 20–30 μ broad, $1\frac{1}{2}$ –2 $\frac{1}{2}$ times as long as broad | <i>R. implexum</i> (2). |

1. **R. Kochianum** Kütz. (incl. *R. implexum* Kütz.).—Filaments pale yellow, forming a fleece-like mass of indefinite extent ; cells 36–54 μ by 10–14 μ .

Forming thin yellowish layers over *Rhodochorton floridulum* and other algæ on muddy rocks near low-water mark. Rare ; widely distributed.

var. **arenicola** Newton (*Conferva arenicola* Berk., *R. arenicola* Reinb.).—Cells $1\frac{1}{2}$ times as long as broad.

Creeping on the sandy margins of tide-pools. Rare ; Cornwall and Dorset.

2. **R. implexum** Batt. (*Conferva implexa* Dillw., *R. tortuosum* Kütz., and *R. rigidum* Gobi). Lat. *implexus*, entwined.—Filaments simple, 20–30 μ in diam., rarely more, yellowish or light green, forming a horizontal fleecy layer ; cells $1\frac{1}{2}$ –2 $\frac{1}{2}$ times as long as broad ; rhizoidal branches none or few, short, non-septate and usually continuous with the cells from which they arise.

Forming a fleecy layer on mud in the littoral belt. Not uncommon ; widely distributed.

3. **R. arenosum** Kütz. (*Conferva arenosa* Carm. and *R. flavicans* Rabenh.). Lat. *arenosus*, sandy.—Filaments slender, rather straight, rigid, forming broad strata ; individual filaments 12.5–15 cm. long ; cells 3–5 times as long as broad.

Forming extended layers, rough and rigid to the touch. On the sandy seashore, at half-tide level. Rare; widely distributed.

4. *R. riparium* Harv. Lat. *riparius*, belonging to the shore. —Filaments pale green, forming an expanded layer, flexuose,

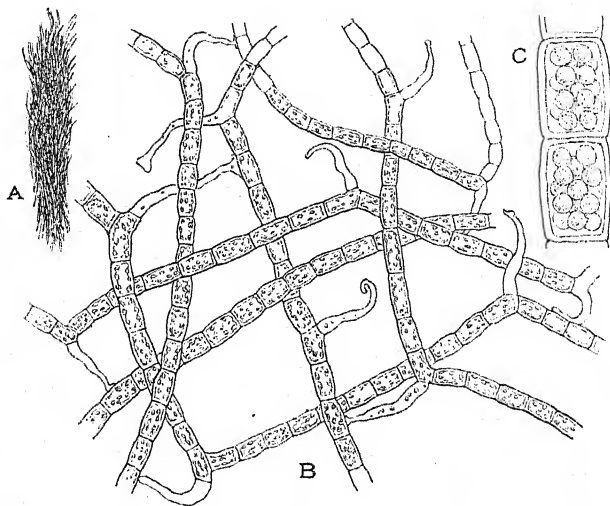


Fig. 61.—*Rhizoclonium riparium* Harv. A. ($\times \frac{3}{8}$); B. Showing rhizoids ($\times 130$); C. cells containing zoospores ($\times 420$).

intertwined into a fleece; cells $20\text{--}25\mu$ broad, rarely larger or smaller, usually once or twice as long as broad; branches and rhizoids frequent, often formed of 2 or 3 cells; substance flaccid, not closely adhering to paper.

On sand-covered rocks near high-water mark. Common; widely distributed.

var. *Casparyi* Holm. & Batt. (*R. Casparyi* Harv.). More slender than the type. Rare; Cornwall.

4. **UROSPORA** Aresch.

(Gr. *oura*, a tail, and *spora*, seed.)

Filaments simple, gelatinous, free or occurring in tufts, sometimes two filaments united laterally; occasionally producing short ramuli. Reproduction by 4-ciliate zoospores elongated into a point at the posterior end; sexual reproduction by the fusion of two 2-ciliate gametes of equal size.

Key.

- | | |
|---------------------------------------------------------------------------------------|---------------------------|
| 1. Filaments less than 70μ broad | 2. |
| Filaments more than 70μ broad | 3. |
| 2. Cells varying from 2-5 times shorter than broad
to twice as long as broad | <i>U. isogona</i> (1). |
| Cells $50-230\mu$ long | <i>U. bangioides</i> (2). |
| 3. Filaments up to 150μ broad, $50-230\mu$ long | <i>U. bangioides</i> (2). |
| Filaments $70-450\mu$ broad, $100-700\mu$ long | <i>U. collabens</i> (3). |

1. *U. isogona* Batt. (*Conferva isogona* Eng. Bot. tab. 1930 *Conferva Youngana* Dillw.; *Urospora penicilliformis* Aresch. ex parte). Gr. *isos*, equal, *gone*, progeny.—Forming yellowish or dark green tufts, 1-8 cm. long; filaments $10-70\mu$ broad; cells varying from 2-5 times shorter than broad to twice as long as broad, the longer ones often barrel-shaped.

Attached to stones, wood and the larger algæ. Not uncommon; widely distributed.

2. *U. bangioides* Holm. & Batt., (*Conferva bangioides* Harv.). *Bangia*, a genus of algæ, Gr. *eidos*, like.—Filaments unbranched, from 7.5-15 cm. long, densely tufted or spreading in large patches; cells $50-230\mu$ by $30-150\mu$, slightly barrel-shaped; plastid filling the cell in the vegetative cells; substance gelatinous, adhering to paper.

On rocks near low-water mark. Not uncommon; widely distributed.

3. *U. collabens* Holm. & Batt. (*Conferva collabens* C. A. Agardh). Lat. *collabens*, crumbling up.—Filaments densely tufted, bright green, 7.5-10 cm. or more in length, of various diams. in the same tuft; cells $100-700\mu$ by $70-450\mu$, filled with numerous plastids, distinctly barrel-shaped; substance flaccid and gelatinous, adhering closely to paper.

Very rare; Yarmouth and Cumbræ.

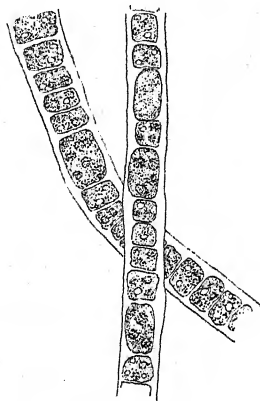


Fig. 62.—*Urospora bangioides* Holm. & Batt.
Vegetative filaments ($\times 600$).

Family II.—GOMONTIACEÆ

Frond formed of creeping branched filaments, cells multinucleate. Asexual reproduction by 2-ciliate zoospores or aplanospores, both produced in sporangia on the upper surface of the horizontal layer, ultimately detached.

GOMONTIA Born. & Flah.

(After Maurice Gomont, French algologist.)

Thallus formed of creeping, freely branched, septate filaments, from the under side of which, many erect, more or less branched filaments arise; cells irregular in shape and size, uninucleate or occasionally multinucleate, plastids ribbon- or shield-like, or a network, with one or two pyrenoids. Reproduction by zoosporangia, producing 4-ciliate zoospores; by aplanospores and by 2-ciliate gametes (?); sporangia arise as segments of the branching filaments, segments enlarging and giving off rhizoidal processes at the proximal end.

Key.

Thallus minute, punctate; cells $44-51\mu$ long *G. manxiana*.
 Forming patches 5-10 mm. broad, cells $15-55\mu$ long ... *G. polyrhiza*.

G. polyrhiza Born. & Flah. Gr. *polus*, many, *rhiza*, a root.—Forming patches 5-10 mm. broad, immersed in the chalky

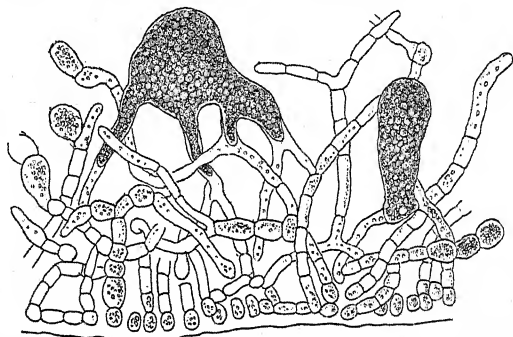


Fig. 63.—*Gomontia polyrhiza* Born. & Flah. Portion with "sporangia" ($\times 300$).

shells of several species of molluscs; creeping freely branched filaments $4-12\mu$ thick; cells $15-55\mu$ long; 'sporangia' irregularly and broadly clavate to nearly cylindrical, up to 240μ by 150μ , producing slightly branched rhizoids at the proximal end.

Not uncommon; widely distributed.

G. manxiana Chodat.—Thallus minute, punctate, orbicular, growing on the surface and in the external layers of a shell; primary filaments $6-8\mu$ broad; inferior branches more or less opposite, upper branches alternate or unilateral, 5μ broad; articulations $44-51\mu$ long; cells somewhat inflated near the septa; large oblong-elliptical cells present, perhaps sporangial; membrane broad, striate, bearing prolongations at the base, sometimes bearing rhizoids and free-living.

Rare; Isle of Man.

Order VI.—SIPHONALES

Fronds filiform, usually much branched or developed into various forms, continuous in the vegetative condition, multinucleate, with many lens- or disc-shaped plastids.

Family I.—BRYOPSIDACEÆ

Vegetative frond unicellular, much branched; plastids disc-like, each with one pyrenoid; axis producing rhizoids at the base, and branches of limited and unlimited growth above. Female gametes large, 2-ciliate; male gametes smaller, brown, 2-ciliate, on separate individuals.

1. **BRYOPSIS** Lamour.

(From *bruon*, a moss, and *opsis*, an appearance.)

Thallus cœnocytic, aseptate, much branched; plastids disc-like, each with one pyrenoid; rhizoids and branches of unlimited and limited growth produced on the axis. Large 2-ciliate female gametes formed in the branches of limited growth, and smaller, brown, 2-ciliate male gametes formed on separate individuals. After fertilisation the resulting zygote germinates immediately.

Key.

Pinnules arising on all sides of the branches *B. hypnoides*.
Pinnules distichous *B. plumosa*.

B. hypnoides Lamour. *Hypnum*, a genus of Mosses, *eidos*, like.—Thallus 5–10 cm. high, pale green, flaccid, profusely branched; branches in no definite order, growing smaller in successive series, clothed with pinnules on all sides, the pinnules themselves being often branched; pinnules usually long and slender, gradually attenuate at the apices, sharply constricted and rounded at the bases.

On rocks or epiphytic on the smaller algæ in tide-pools in shaded situations, also on *Laminaria saccharina*, below low-water mark. Rather rare in England and Scotland; not uncommon on the west of Ireland.

B. plumosa C. A. Agardh. Lat. *plumosus*, feathered.—Thallus not more than 10 cm. high, usually once or twice branched, the ultimate branches clothed with distichous slender pinnules, gradually attenuate upwards, slightly attenuate and rounded below, the general outline of the branched frond being pyramidal; substance glossy and flaccid, adhering closely to paper.

On rocks and small stones and on the sides of rock pools. Not uncommon; widely distributed.

var. *nuda* Holm.—Ramuli few; confined to the tips of the branches. Dorset.

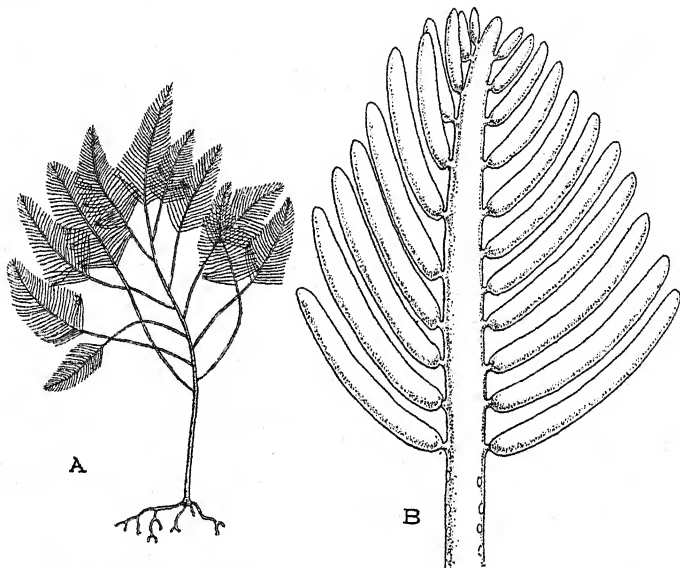


Fig. 64.—*Bryopsis plumosa* C. A. Agardh.—A. Thallus ($\times 1$); B. ($\times 35$).

Family II.—VALONIACEÆ

Frond originating in a vesicular or clavate cell of limited growth, in all but lowest forms branching or dividing into many cells, irregularly arranged or forming symmetrical, sometimes net-like fronds; intercalary cell-division by ordinary wall-formation not common, new cells arising by outgrowth of parent.

HALICYSTIS Aresch.

(Gr. *hals*, the sea, and *kustis*, a bladder.)

Thallus ovoid or globular, aseptate, multinucleate with penetrating rhizoidal portion; plastids small, disc-like; pyrenoids absent. Asexual reproduction by 2-ciliate zoospores escaping through one or more openings; similar but small zoospores or possibly zoogametes may be formed in separate individuals; after spore dispersal the openings close and several spore-generations may be produced.

H. ovalis Aresch. (*Valonia ovalis* C. A. Agardh).—Thallus solitary or gregarious, obovate-ovoid, 0.5–1 cm. high, about 0.25–0.5 cm. broad; membrane tough, 10–12 μ thick; basal

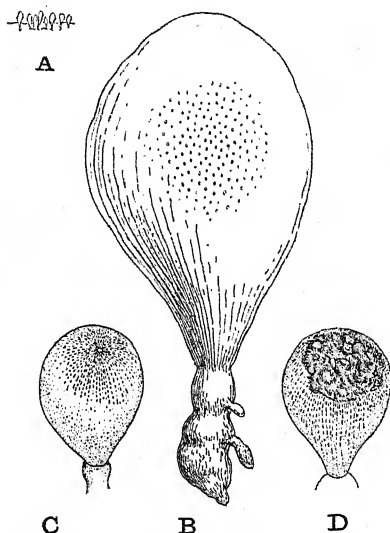


Fig. 65.—*Halicystis ovalis* Aresch. A. ($\times 1$); B. ($\times 300$); C. and D. Spore formation ($\times 100$). (After Kuckuek).

prolongation penetrating the substratum; zoospores 12–14 μ by 7–8 μ , small zoospores (gametes?) 7–8 μ by 2–3 μ .

Very rare, obtained only by dredging; Scotland and Ireland.

Family III.—DERBESIACEÆ

Frond filiform, unicellular or with occasional septa, multinucleate, simple or branched, with no differentiation of axis and branches; plastids disc-like, with or without pyrenoids. Asexual reproduction by large multiciliate zoospores, formed in lateral cells partitioned off from the filaments.

DERBESIA Solier

(After Alphonse Derbès, French algologist.)

Filaments aseptate or with occasional partitions, multinucleate, simple or branched, with no differentiation of axis and branches; plastids numerous, disc-shaped, with or without pyrenoids. Asexual reproduction by large multiciliate zoospores, formed in lateral, globose or pyriform sporangia; sexual reproduction unknown.

D. tenuissima Crouan (*Vaucheria marina* Harv.). Lat. *tenuissimus*, most slender.—Plant bright green; filaments arising from a procumbent portion, $50-70\mu$ in diam., simple or often bearing a few lateral branches, aseptate except for an occasional

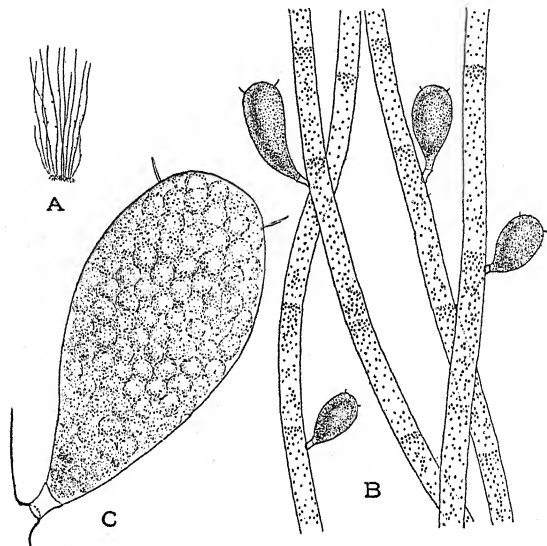


Fig. 66.—*Derbesia tenuissima* Crouan. A. ($\times 3$); B. Filaments with sporangia ($\times 60$); C. Single sporangium ($\times 300$).

cross-wall near the base of a branch. Sporangia ovoid to sub-spherical, borne laterally, $150-250\mu$ by $90-200\mu$, pedicel $30-70\mu$ by $30-35\mu$; 20 or more zoospores in each sporangium.

On sea-plants, mud, etc., between the tide-marks. Rare; Devon, Dorset and Argyle.

Family IV.—PHYLLOSIPHONACEÆ

Thallus filiform, inarticulate, branching; perforating mollusc shells or parasitic in the tissues of plants. Asexual reproduction by aplanospores in one genus; sexual reproduction unknown.

OSTREOBIMUM Born. & Flah.

(Gr. *ostreon*, an oyster, and *bios*, life.)

Thallus filamentous, branched with occasional swellings; living in the shells of molluscs. Reproduction unknown.

O. Queketti Born. & Flah. After E. J. Quekett, British microscopist.—Thallus slender, $4-5\mu$ in diam. in the main divisions, numerous lateral divaricate branches forming a close

network, the ultimate divisions about 2μ in diam.; occasional irregular swellings in the filaments, 20–40 μ in diam.

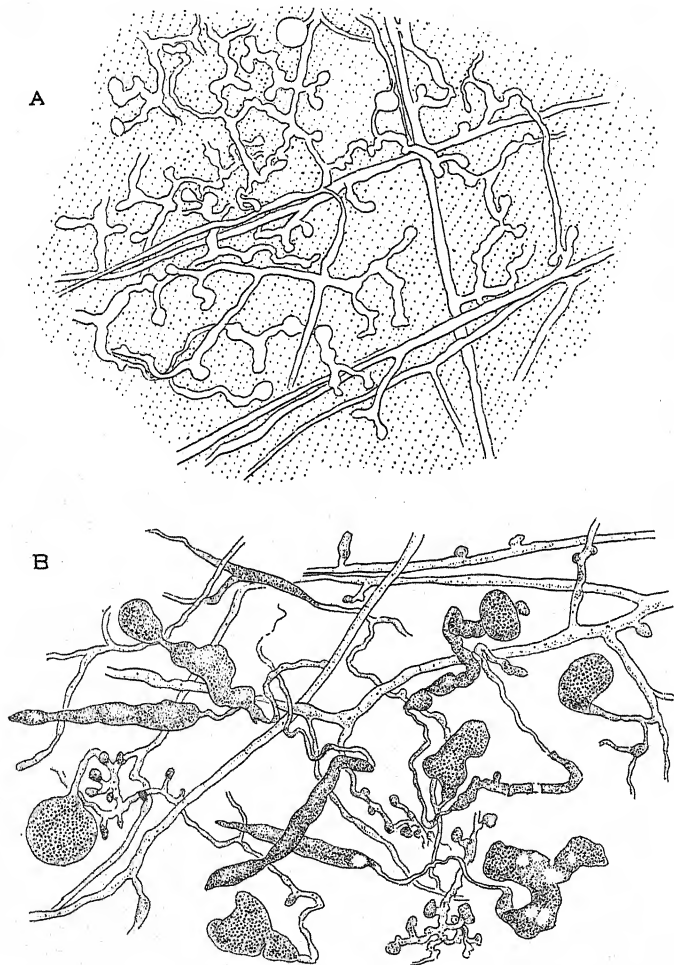


Fig. 67.—*Ostreobium Queketti* Born. & Flah. A. Branching thallus ($\times 300$); B. Showing swellings ($\times 300$).

In old shells of oysters and other molluscs. Often occurring with *Gomontia polyrhiza*, from which it is easily distinguished by the continuous, non-cellular filaments. Not uncommon; widely distributed.

Family V.—VAUCHERIACEÆ

Fronds filamentous, cylindrical or with frequent constrictions, with lateral or dichotomous branching; plastids disc-like, pyrenoids absent. Asexual reproduction by large multinucleate zoospores, by aplanospores and akinetes; sexual reproduction by oogonia and antheridia.

VAUCHERIA DC.

(After M. Vaucher, Swiss algologist.)

Fronds bright green, cœnocytic, aseptate, composed of long irregularly or falsely dichotomising branching filaments. Monœcious or dioecious; oogonia sessile or stalked, containing a single oospore; antheridia often spirally twisted and formed at the tips of the branches, sometimes ovoid; antherozoids small, 2-ciliate; asexual reproduction by large zoospores clothed with cilia arranged in pairs, and non-motile aplanospores.

Key.

- | | |
|------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Antheridia borne on a colourless cell cut off from the cœnocyte | 2. |
| Antheridia sessile or stalked, but not borne on a special stalk-cell | 5. |
| 2. Androphore on which antheridia are developed borne on a stalk-cell | <i>V. symandra</i> (3). |
| Androphore absent | 3. |
| 3. Oogonia separated from the cœnocyte only by a cross-wall, not borne on a special cell | 4. |
| Oogonia borne on a special cell with a cross-wall | <i>V. litorea</i> (6). |
| 4. Oogonia with several openings at their apices ... | <i>V. coronata</i> (5). |
| Oogonia with one opening | <i>V. sphaerospora</i> (4). |
| 5. Oogonia and antheridia on separate filaments ... | <i>V. dichotoma</i> (1). |
| Oogonia and antheridia on the same filament ... | <i>V. Thuretii</i> (2). |

1. *V. dichotoma* Lyngb. var. *submarina* C. A. Agardh. Gr. *dichotomeo*, I cut in two.—Filaments 50–220 μ , rarely as much as 343 μ diam. Oogonia and antheridia on separate filaments; oogonia sessile, spherical or slightly elongated, 374 μ by 330 μ ; ostiole minute, terminal; antheridia 110–232 μ by 75–153 μ , egg-shaped or ellipsoidal, sessile, borne singly or in groups.

Rare; Dorset and Argyle.

2. *V. Thuretii* Woron. (*V. velutina* Harv. partim). After G. Thuret, French algologist.—Filaments 60–122 μ broad, rarely as small as 30 μ broad. Oogonia and antheridia on the same filament; oogonia borne singly, egg-shaped or pyriform, shortly stalked, rarely sessile, 130–300 μ broad; oospore 170–240 μ by 120–200 μ ; antheridia erect or horizontal, egg-shaped or pyriform, 60–150 μ by 40–80 μ ; aplanospores borne terminally on short lateral branches.

On the muddy seashore and mud-covered rocks between the tide-marks. Probably not uncommon; widely distributed.

3. *V. synandra* Woron. Gr. *syn*, with, *aner*, a man. Filaments 50–100 (usually 88) μ diam. Antheridia horn-shaped, 2–7 borne together on a swollen, chlorophyll-containing cell (androphore), which itself is borne on a small colourless cell, cut off from the main cœnocyte; oogonia lateral on the filament, almost spherical, 100–110 μ broad; oospore spherical, monœcious. Rare; Lancashire.

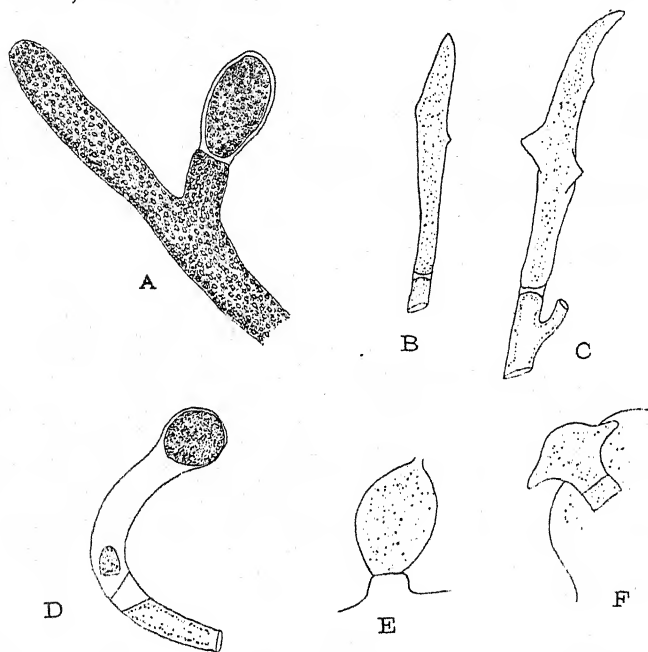


Fig. 68.—*Vaucheria*. A. Filament bearing uniloc. sporang. with one zoospore ($\times 80$); B–D. *V. litorea* Bang & Agardh. B and C. Filament bearing antheridia ($\times 45$); D. Filament with oogonium ($\times 45$); E. *V. Thuretii* Woron. Antheridium; F. *V. Sphaerospora* Nordst. Antheridium. (Figs. B–F after Pascher.)

4. *V. sphaerospora* Nordst., var. *synoica* Nordst. Gr. *sphaira*, a sphere, *spora*, a seed.—Filaments 25–60 μ diam., loosely tufted. Antheridium generally slightly curved, acuminate, bearing two conical processes just below the apex; oogonium below on the same branch, separated by an empty cell, globose or nearly so, 105–135 μ in diam.; oospore not filling the oogonium. Rare; widely distributed.

var. *dioica* Rosenv.—Dicecious; antheridia single or in pairs; oogonia pear-shaped, shortly stalked. Not uncommon.

5. *V. coronata* Nordst. Lat. *coronatus*, crowned.—Filaments 48–70 μ in diam. Oogonia solitary, sessile, borne on the branches bearing the antheridia, more rarely on the main

filaments, obovoid or obliquely ovoid, $125-145\mu$ by $145-180\mu$, bearing a circle of 3-6 openings at the top; oospore globose or subglobose, $115-135\mu$ by 145μ , not quite filling the oogonium; ripe oospore with occasional brown spots and thick minutely fitted membrane; antherida straight with rounded apex, usually in pairs, sometimes solitary, $30-40\mu$ in diam., separated from the branch by an empty cell.

Rare; Forfar.

6. *V. litorea* Bang & Agardh. Lat. *litoreus*, living on the shore.—Filaments $70-95\mu$ broad. Antheridia borne on branchlets, each separated by a colourless cell from the main cenocyte, elongated, cylindrical, $55-65\mu$ broad, bearing 1-4 lateral beak-like prolongations through which the antherozoids are finally freed; oogonia terminal each on a recurved elongated stalk, at the base of which a colourless cell is cut off by a cross-wall; oogonium almost spherical, $190-450\mu$ in diam.; dicecious.

Rather rare; widely distributed.

Family VI.—CODIACEÆ

Frond of definite shape except in the lowest forms, composed of interwoven, continuous, branching filaments, sometimes with constrictions. Asexual reproduction by zoospores and aplano-spores formed in sporangia; sexual reproduction by isogamous or anisogamous gametes.

1. CODIUM Stackh.

(Gr. *kodion*, the skin of an animal.)

Thallus spongy, not encrusted with lime, sub-spherical, cylindrical or forming a felted encrustation, simple or dichotomously branched, dark green; medullary filaments vertically entwined, giving rise to horizontal branchlets with swollen tips forming a continuous external "palisade" layer. Multiplication by fragmentation of the thallus; sexual reproduction by the fusion of 2-ciliate gametes produced in gametangia borne laterally on the palisade cells; dicecious or occasionally monœcious.

Key.

- | | |
|-------------------------------------------------------------|---------------------------|
| 1. Thallus prostrate | <i>C. adhærens</i> (1). |
| Thallus erect. | 2. |
| 2. Thallus spherical and hollow | <i>C. bursa</i> (4). |
| Thallus of another form | 3. |
| 3. Thallus minute, erect, cylindrical | <i>C. amphibium</i> (2). |
| Thallus cylindrical or flattened, branched, elongated | <i>C. tomentosum</i> (3). |

1. *C. adhærens* C. A. Agardh.—Forming a broad green, sponge-like, felted encrusting layer, composed of interwoven filaments forming a basal layer, from which linear-clavate vertical branches of equal length form a palisade layer. Gametangia borne laterally on the clavate cells; substance soft and gelatinous, closely adhering to paper.

On marine rocks near low-water mark. Rare; Ireland, Isle of Man, S. England and Channel Islands.

2. *C. amphibium* Moore.—Fronds minute, erect, cylindrical, simple, obtuse, aggregated in widely spreading strata, bright

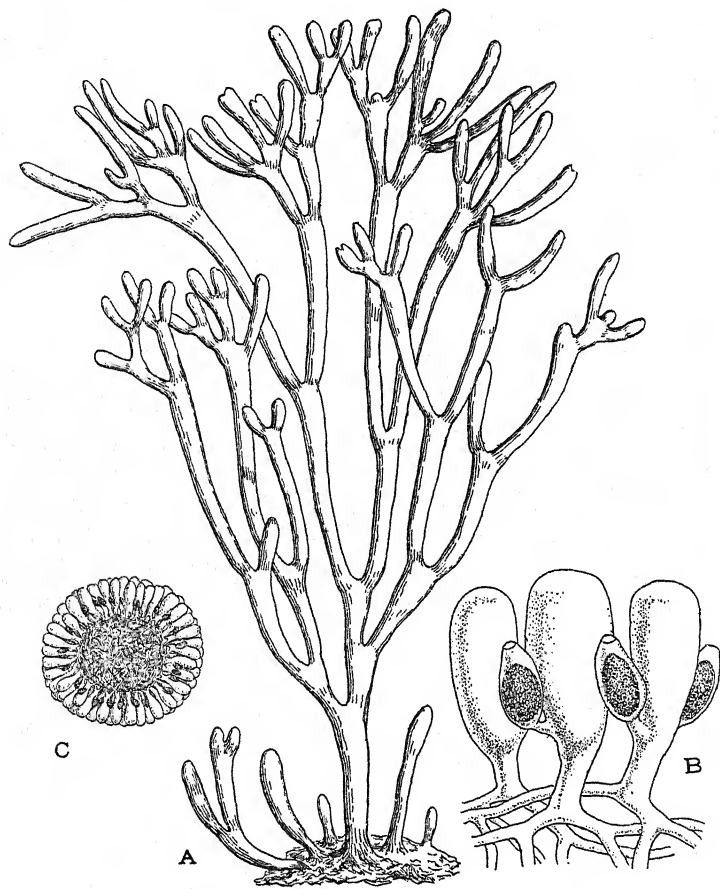


Fig. 69.—*Codium tomentosum* Stackh. A. ($\times \frac{2}{3}$); B. Portion of trans. sect. of thallus with gametangia ($\times 60$); C. Trans. sect. of thallus ($\times 12$).

green; lower stratum indefinite, formed of entangled filaments from which papillate, cylindrical or clavate fronds arise perpendicularly, as much as 1.25 cm. in height; axes of the erect fronds formed of interwoven filaments from which clavate filaments arise forming a continuous peripheral layer; substance soft.

Very rare; Cornwall, Isle of Man and Ireland.

3. *C. tomentosum* Stackh. Lat. *tomentosus*, covered with matted hairs.—Thallus much branched, 22–37 cm. long when growing in pools, 48–60 cm. long in deep water; branches 3–4 mm. thick, cylindrical, often slightly flattened at the axils, dichotomous, surface often tomentose, becoming smooth with age; attachment organ formed of a felt-like mass of entangled filaments creeping over the substratum; centre of the branches formed of intertwined filaments from which clavate filaments arise forming a continuous outer layer; clavate filaments 120–170 μ (rarely 220 μ) wide, with apex distinctly thickened and blunt or at times pointed, but never mucronate.

Not uncommon.

var. *atlanticum* Cotton. More robust than the type, utricles often mucronate.

4. *C. Bursa* C. A. Agardh. *Bursa*, a generic name used by C. Bauhin.—Frond dark green, paler when dry, sponge-like, attached to the rock by interwoven and matted fibres, several fronds growing together, spherical, hollow, varying in diam. from 2.5–20 cm., composed of slender filaments from which club-shaped proliferations arise vertically forming a continuous outer layer; substance soft.

On submarine rocks. Very rare; S. England, Channel Islands and Ireland.

PHÆOPHYCEÆ

Key to Genera

- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1. Reproductive organs borne in conceptacles below the surface of the thallus | 2. |
| Reproductive organs not in conceptacles, protruding or sunk in the thallus..... | 5. |
| 2. Attachment-organ formed of branching fibres which extend in patches over the substratum | Bifurcaria (p. 223). |
| Attachment-organ disc-like, more or less expanded | 3. |
| 3. Vegetative thallus cup-shaped, stalked. Long, strap-like, dichotomous fronds bearing fruiting bodies arising from the centre, without air vesicles | Himanthalia (p. 223). |
| Thallus flat, dichotomous, with mid-rib. Fruiting-bodies developed in the apices of the thallus; air-vesicles frequently present, generally developed beside the mid-rib in the leaf-like lamina | Fucus (p. 216). |
| Thallus stem-like and terete or compressed, much branched | 4. |
| 4. Thallus flattened, almost pinnately branched with large oval air-vesicles in the branches. Fruiting-bodies egg-shaped, stalked, developed singly or in lateral bunches | Ascophyllum (p. 219). |

- Thallus flattened, dichotomous, pinnately branched. Fruiting-bodies and air-vesicles developed in the upper branches; air-vesicles pod-shaped, articulate, fruiting-body lancet-like Halidrys (p. 225).
- Thallus terete or compressed, variously branched; air-vesicles (when present) in the axes of the branches, borne singly or in chains. Conceptacles small, wart-like, developed in the branches Cystoseira (p. 226).
- Thallus narrow, channelled on one side, air-vesicles absent. Fruit in terminal receptacles Pelvetia (p. 223).
5. Thallus encrusting, not felted on the underside, having a basal cell-layer creeping in or on the substratum 6.
- Thallus flat, membranous, horizontally expanded over the substratum, attached by felty rhizoids 16.
- Thallus irregularly spherical, hollow 17.
- Thallus forming small, solid, gelatinous spheres or cushions from which articulated filaments may arise 18.
- Thallus conspicuous, more or less compressed, leafy or ribbon-like 23.
- Thallus filamentous or terete, simple or branched, solid or tubular 33.
6. Thallus epiphytic or parasitic on other algae; having a horizontal cell-layer, and short erect filaments 7.
- Thallus forming a blackish brown crust with parenchymatous structure; on stones 8.
7. Erect filaments few or absent 10.
- Erect filaments numerous 11.
8. Unilocular sporangia projecting from the surface 9.
- Unilocular sporangia borne at the base of the filaments forming the sorus, not projecting from the surface Ralfsia (p. 152).
9. Unilocular sporangia developed directly from the surface cells Lithoderma (p. 127).
- Unilocular sporangia borne on elongated filaments projecting from the surface layer Battersia (p. 191).
10. Plurilocular sporangia in dense masses of squarish cells, occupying central part of frond Phæostroma (p. 125).
- Sporangia not confined to the centre of the thallus Mikrosyphar (p. 124).
11. Ascocysts present Ascocyclus (p. 158).
- Ascocysts absent 12.
12. Unilocular sporangia arising from cells of the basal layer, sessile or shortly stalked 13.
- Unilocular sporangia terminal on the erect filaments Symphyocarpus (p. 126).

13. Erect filaments and sporangia normally distributed over the whole colony Myrionema (p. 149).
 Erect filaments and sporangia normally not distributed over the whole colony 14.
14. Erect filaments and sporangia normally arising from only central part of basal layer 15.
 Erect filaments and sporangia normally arising in dense groups of irregular form separated by vacant spaces Chilionema (p. 157).
 Attachment-rhizoids developed from the basal layer Ulonema (p. 154).
 Attachment-rhizoids absent Hecatonema (p. 155).
15. Thallus membranous or cartilaginous, umbilicate, brown when young, blackish brown later; surface cells drawn out into free articulated filaments Zanardinia (p. 199).
 Thallus delicately membranous, lobed, not umbilicate, olive-brown; surface cells not drawn out into free articulated filaments Aglaozonia (p. 199).
17. Limiting layer formed of club-shaped filaments Leathesia (p. 141).
 Limiting layer formed of small rectangular assimilating cells Asperococcus (p. 170).
18. Thallus bearing free assimilating filaments 19.
 Thallus spherical or cushion-like without free assimilating filaments 22.
19. Free filaments arising from a stratum of different character, constituting an important part of the vegetative plant ... 20.
 Lower stratum chiefly an organ of attachment Halothrix (p. 132).
20. Free filaments all alike 21.
 Free filaments of two kinds, one short, the other exserted Elachistea (p. 133).
21. Sporangia intercalary Leptonema (p. 131).
 Sporangia lateral Myriactis (p. 142).
22. Cortical layer of the thallus consisting of simple linear filaments; forming a minute cushion on other algae Microcoryne (p. 139).
 Cortical layer consisting of simple club-shaped filaments; thallus small, spherical, on Cystoseira and other algae Leathesia (p. 141).
 Cortical layer consisting of dichotomous threads; on slopes of rocks or on encrusting algae Petrospongium (p. 140).
23. Thallus with a more or less developed mid-rib 24.
 Thallus without mid-rib 25.
24. Thallus large, leafy, stalked, simple, with thick mid-rib; zoosporangia in special fruiting-bodies, arising on the stipe..... Alaria (p. 206).
 Thallus flat, with mid-rib; sporangia borne in special fruiting-bodies which arise terminally on the branches Carpomitra (p. 137).
 Thallus flat, membranous, dichotomous, with clear mid-rib; sporangia in groups on both sides of mid-rib Dictyopteris (p. 216).

- Thallus ribbon-like, branches opposite, pinnate, mid-rib more or less conspicuous, margin serrate, clothed in summer with filamentous hairs *Desmarestia ligulata* (p. 164).
25. Thallus ribbon-like, incompletely tubular; zoosporangia in sori, in the thallus *Asperococcus compressus* (p. 172).
- Thallus solid 26.
26. Thallus very large, leafy, with long stipe, leafy bodies membranous or leathery, oval or elongated, simple or digitately cleft 27.
- Thallus short and delicately stalked 28.
- Thallus without true stipe, attenuate at the base, attachment-organ felty 29.
27. Stipe flat, arising from a hollow warty base *Saccorhiza* (p. 204).
- Stipe cylindrical, attached by branching rhizoids *Laminaria* (p. 202).
28. Zoosporangia and clusters of hairs borne in groups on the thallus, giving a punctate appearance *Punctaria* (p. 184).
- Thallus smooth; zoosporangia forming a continuous layer in the outer cells *Phyllitis* (p. 176).
29. Thallus leafy, fan-like, simple, digitate or almost dichotomously branched; sporangia in groups, forming concentric zones on the thallus 30.
- Thallus dichotomously divided; sporangia in groups on the thallus 32.
30. Sporangia formed in groups among paraphyses, projecting from the surface of the thallus; thallus fan-shaped, irregularly divided *Cutleria* (p. 197).
- Sporangia developed in the surface cells of the thallus 31.
31. Thallus fan-shaped, simple or much divided, with lime encrustation; sporangia forming dark and light concentric zones; upper edge rolled back *Padina* (p. 214).
- Thallus fan-shaped, irregularly dichotomous, upper edges serrate, not encrusted with lime, concentric zones present *Taonia* (p. 213).
32. Thallus regularly dichotomous, apices not clothed with hairs; sporangia developed in the cells of the thallus *Dictyota* (p. 211).
- Thallus fan-shaped, di-polychotomously divided, apices clothed with hairs; sporangia developed among clusters of paraphyses *Cutleria* (p. 197).
33. Thallus consisting of free articulated mono- or polysiphonous filaments, not associated into a tissue, sometimes partly corticate 34.
- Thallus filamentous or terete, solid or tubular, formed of a parenchymatous or filamentous tissue 51.

34. Thallus monosiphonous, with possibly some polysiphonous articulations 35.
 Thallus polysiphonous throughout, with a more or less developed parenchymatous cortical layer in the main axes 46.
35. Asexual reproduction by tetra-nucleate monospores 36.
 Asexual reproduction by unilocular sporangia 38.
36. Monosiphonous throughout Acinetospora (p. 210).
 Few polysiphonous articulations at the base 37.
37. Branches issuing irregularly from all sides of the stem Haplospora (p. 208).
 Branches opposite, regularly pinnate, of unequal length Tilopteris (p. 210).
38. Sporangia intercalary not on special stichidia Pilayella (p. 124).
 Sporangia terminal or lateral 39.
39. Filament monosiphonous, articulated throughout 40.
 Filament partly polysiphonous, articulated 45.
40. Microscopic algæ, creeping, or about 1 mm. in height 41.
 Filamentous algæ, much branched, lower part sometimes corticate, unilocular sporangia lateral or terminal, plurilocular sporangia intercalary Isthmoplea (p. 182).
 Large tufted algæ; filaments much branched, lower part sometimes corticate; unilocular sporangia usually oval, plurilocular sporangia siliquose, oval or elongated Ectocarpus (p. 113).
 Forming tufts, filaments much branched laterally; plurilocular sporangia like bunches of grapes on a single articulated filament Sorocarpus (p. 130).
41. Frond prostrate 44.
 Erect filaments present 42.
42. Erect filaments in dense tufts 43.
 Erect filaments scattered Streblonema (p. 128).
43. Erect filaments, clavate, gelatinous Strepsithalia (p. 151).
 Erect filaments linear, not gelatinous Sphacella (p. 192).
44. Plurilocular sporangia in dense masses of squarish cells, occupying central part of frond Phæostroma (p. 125).
 Sporangia not confined to the centre of the plant Mikrosyphar (p. 124).
45. Thallus small, often forming microscopic cushions, consisting of a primary branched filament, from which monosiphonous articulated branches arise, simple or clothed with branchlets; sporangia arising from polysiphonous filament Myriotrichia (p. 174).

- Forming small cushions, consisting of a polysiphonous upper portion, and monosiphonous lower parts from which branched articulated filaments arise; unilocular sporangia in wart-like groups on the polysiphonous parts; plurilocular sporangia elongated, formed at the bases of the filaments..... Giraudia (p. 135).
- Filamentous algae, much branched, lower part sometimes corticate; unilocular sporangia lateral or terminal; plurilocular sporangia intercalary Isthmoplea (p. 182).
46. Apical cells not conspicuous; unilocular sporangia developed from the cortical cells at the nodes, not on special branches Phlæospora (p. 187).
- Apical cells conspicuous; unilocular sporangia on special branches 47.
47. Branches formed by division of an initial cell below the apical cell 48.
- Branches formed by direct division of the apical cell..... 50.
48. Rhizoidal filaments few and limited to the base of the plant, branching irregularly pinnate Sphacelaria (p. 188).
- Rhizoidal filaments numerous 49.
49. Branches distichously pinnate Chætopteris (p. 192).
- Branches whorled Cladostephus (p. 194).
50. Central portion of axis consisting of 4 large central cells, surrounded by a band of smaller cells Halopteris (p. 196).
- Central portion of axis consisting of a large number of squarish cells, surrounded by a band of smaller cortical cells Stypocaulon (p. 197).
51. Thallus simple, solid or tubular 52.
- Thallus branched, solid, rarely tubular ... 56.
52. Fronds 0.6-3 cm. in length, solid, assimilating filaments at right angles to the surface Buffhamia (p. 143).
- Fronds cylindrical, solid, consisting of concentric cell-layers Litosiphon (p. 180).
- Fronds tubular 53.
53. Substance thin 54.
- Substance cartilaginous, numerous diaphragms present Chorda (p. 200).
54. Frond consisting of a single layer of cells ... Phæosaccion (p. 183).
- Frond consisting of more than one layer... 55.
55. Sporangia covering surface Scytosiphon (p. 177).
- Sporangia external in scattered patches ... Asperococcus (p. 170).
56. Thallus consisting of a filamentous core, from which articulated filaments arise, covered more or less completely by a gelatinous substance; sporangia developed on or from the filaments of the outer layer; substance gelatinous or cartilaginous 57.
- Thallus parenchymatous throughout 60.

57. Cortical filaments short, sparingly branched, closely packed, enclosing pyriform unilocular sporangia Gobia (p. 170).
 Cortical filaments not enclosing unilocular sporangia 58.
58. Thallus cartilaginous, core solid, formed of a firm parenchyma, cortical filaments simple Chordaria (p. 144).
 Thallus gelatinous, core solid or tubular, forming a more or less perforated tissue; cortical filaments generally bent and branched, rarely simple 59.
59. Plurilocular sporangia replacing the upper articulations of the cortical filaments; core solid or hollow Castagnea (p. 146).
 Plurilocular sporangia intercalary, ramuli moniliform; core hollow Myriocladia (p. 159).
 Plurilocular sporangia elongated or ovoid, stalked, borne laterally on the cortical filaments; core solid, firm Mesogloia (p. 147).
60. Axis and branches with conspicuous filamentous hairs arranged in groups or whorls, or terminating the apices of the branches 61.
 Clear groups of hairs absent 64.
61. Thallus consisting of a filamentous branched axis, clothed with whorls of hairs, from which moniliform sporangia arise Arthrocladia (p. 166).
 Hairs not whorled 62.
62. Sporangia on special elongated or club-shaped fruiting-bodies 63.
 Sporangia not in special stichidia; thallus filamentous, compressed or flat; branches clothed with clusters of hairs or thorny processes Desmarestia (p. 164).
63. Fruiting-bodies on short lateral branches, crowned by a cluster of hairs Sporochnus (p. 137).
 Fruiting-bodies terminal on the branches Carpomitra (p. 137).
64. Thallus filamentous, solid or later becoming tubular; sporangia in sori, distributed in numbers, projecting from the surface of the thallus 65.
 Thallus filamentous, solid or hollow; sporangia formed from the cortical cells, borne singly or in groups 66.
65. One apical cell terminating each branch ... More than one apical cell terminating each branch Stilophora (p. 162).
66. Thallus tubular; sporangia in groups forming transverse striæ on the thallus Striaria (p. 172).
 Thallus solid or tubular; sporangia formed in the cortical cells, half projecting or completely sunk, singly or in irregular groups Stictyosiphon (p. 179).
 Lower half tubular, upper parts solid; sporangia developed in the cells of the cortex, sunk, strewn over the thallus Dictyosiphon (p. 167).
 Lower parts tubular, upper parts solid; sporangia in pairs in the cells of the cortex at the nodes Phlæospora (p. 187).

Order I.—ECTOCARPALES

Thallus leaf-like, tubular or formed of branched filaments; growth usually intercalary, typical meristematic apical cells being rarely present; gametes almost equal in size.

Family I.—ECTOCARPACEÆ

Plants filamentous, branched; growth intercalary or trichothallic or apical without longitudinal subdivision of the cells of the filaments. Gametangia or sporangia borne on all or part of an ultimate branch; gametes isogamous or anisogamous.

1. ECTOCARPUS Lyngb.

(Gr. *ektos*, external, and *karpos*, fruit.)

Fronds filamentous, monosiphonous or occasionally partly polysiphonous by radial division of some of the cells. Pluriloc. sporang. ovate, cylindrical or siliculose, consisting of numerous small cells arranged in regular longitudinal and transverse series; uniloc. sporang. cylindrical or oval, either stalked or formed by the direct transformation of the cells of the branches.

Key.

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| 1. Parasitic species | 2. |
| Non-parasitic species | 12. |
| 2. On Florideæ | 3. |
| On Phæophyceæ | 4. |
| On <i>Codium tomentosum</i> | <i>E. simplex</i> (14). |
| 3. External filaments simple | <i>E. parasiticus</i> (1). |
| External filaments branched | <i>E. microscopicus</i> (8). |
| 4. Forming patches on <i>Laminaria saccharina</i> | <i>E. tomentosoides</i> (10). |
| Growing between the assimilating filaments of <i>Stilophora rhizodes</i> | <i>E. Stilophorce</i> (2). |
| On other algæ | 5. |
| 5. Forming small isolated tufts on the exterior of the host | 6. |
| Forming larger patches, or a more continuous layer | 8. |
| 6. Assimilating filaments attenuate at the base, parasitic on Fuci | <i>E. clandestinus</i> (3). |
| Assimilating filaments not attenuate at the base | 7. |
| 7. Lax tufts on <i>Taonia atomaria</i> | <i>E. Battersii</i> (12). |
| Compact tufts on <i>Ralfsia</i> | <i>E. microspongium</i> (9). |
| 8. Endophytic thallus little developed, formed of a small number of cells | <i>E. solitarius</i> (13). |
| Endophytic thallus penetrating the outer layers, forming a small patch of pseudo-parenchyma; pluriloc. sporang. cylindrical, fusiform | <i>E. luteolus</i> (6). |

- Endophytic thallus penetrating deeply,
forming an interlacing mass of tissue ... 9.
9. External filaments not more than 1 mm.
in length 10.
- External filaments attaining a length of
3 mm.; pluriloc. sporang. oval *E. velutinus* (11).
10. Pluriloc. sporang. cylindrical, fusiform ... *E. minimus* (7).
- Pluriloc. sporang. ovoid 11.
11. Plant having no apparent action on the
host *E. brevis* (4).
- Gall-like swelling formed in the region of
the parasite *E. Valiantci* (5).
12. Rarely exceeding 1 cm. in height, epiphytic,
or less frequently on shells or stones ... 13.
- Plants more than 1 cm. in height 20.
13. Erect filaments 1-3 mm. high, growing on
Padina pavonia *E. Padince* (39).
- Not growing on *Padina* 14.
14. Erect filaments simple 15.
- Erect filaments branched 16.
15. Pluriloc. sporang. arising from the pro-
cumbent filaments *E. repens* (15).
- Pluriloc. sporang. terminal or lateral on the
erect filaments *E. terminalis* (16)
- 16 Plants 1-5 mm. in height 17.
- Plants more than 5 mm. in height 18.
17. Uniloc. sporang. terminal *E. terminalis* (16).
- Uniloc. sporang. lateral and sessile *E. acanthophorus* (34).
18. On rocks or woodwork near high-water
mark *E. Holmesii* (18).
- Epiphytic on other algæ 19.
19. Pluriloc. sporang. siliqueose *E. Lebelii* (38).
- Pluriloc. sporang. ovate or more elongated
..... *E. irregularis* (20).
20. In tufts, not more than 2 cm. in height,
branches never opposite, pluriloc.
sporang. often in a series *E. secundus* (36).
- More than 2 cm. high 21.
21. Filaments interwoven into a dense sponge-
like branching thallus, resembling *Codi-
dium tomentosum* *E. tomentosus* (28).
- Filaments not so interwoven 22.
22. Plants 2-5 cm. high 23.
- Plants 5-30 cm. or more high 31.
23. In tufts, filaments 1-3 cm. long, branches
terminating in a hair, attached by
articulated rhizoids *E. ovatus* (29).
- Plants not tufted 24.
24. Branches clothed with secund ramuli bear-
ing closely set subulate series on their
inner faces *E. Hincksiae* (30).
- Branches without secund ramuli 25.
25. Ramuli short spine-like, horizontal (not
obtuse) *E. Landsburgii* (33).
- Ramuli not spine-like 26.
26. Branches few 27.
- Branches many 29.
27. Branches alternate 28.
- Branches not alternate, pluriloc. sporang.
sessile, erect, adpressed to the branches,
lanceolate *E. erectus* (17).

- | | |
|------------------------------------------------------------------------------------------------------|------------------------------|
| 28. Pluriloc. sporang. stalked, elliptic-oblong or fusiform | <i>E. fenestratus</i> (37). |
| Upper sporangia almost sessile, siliquose... | <i>E. Crouani</i> (23). |
| 29. Branches single or in unilateral series | <i>E. Sandrianus</i> (21). |
| Branches alternate | 30. |
| 30. Sporangia single | <i>E. globifer</i> (19). |
| Sporangia many | <i>E. Mitchellæ</i> (22). |
| 31. In tufts, 5-7 cm. in height, each branch terminating in a pluriloc. sporang. when in fruit | <i>E. dasycarpus</i> (26). |
| Pluriloc. sporang. not apical | 32. |
| 32. Pluriloc. sporang. elongated, subulate | 33. |
| Pluriloc. sporang. rounded or oval | 35. |
| 33. Ramuli appearing markedly fasciculate at the tips of the branches | <i>E. fasciculatus</i> (27). |
| Ramuli not fasciculate | 34. |
| 34. Primary filaments distinct, branching alternate or secund | <i>E. confervoides</i> (24). |
| Without conspicuous main axes, branching alternate or pseudodichotomous | <i>E. penicillatus</i> (25). |
| 35. Ramuli short, spine-like and obtuse | <i>E. distortus</i> (32). |
| Ramuli not spine-like | 36. |
| 36. Branches opposite, free, feathery, uniloc. sporang. borne on upper side | <i>E. granulatus</i> (35). |
| Branches not opposite | 37. |
| 37. 4-12 cm. long, branches single or in a unilateral series | <i>E. Sandrianus</i> (21). |
| 10-30 cm. long, branching alternate or pseudo-dichotomous | <i>E. Reinboldii</i> (31). |

1. PARASITIC SPECIES

1. *E. parasiticus* Sauv.—Filaments in the early stage growing in the axis of the host-plant, ultimately forming more or less limited dark spots in the cortical layer, composed of many creeping and a few erect threads; external threads may be assimilating filaments or true hairs; sporiferous threads unbranched, forming clusters about 1 mm. in diam., by which the cortical layer of the host-plant is sometimes ruptured. Pluriloc. sporang. sessile or on a pedicel composed of one or two cells; divisions of the sporangia sometimes simple, sometimes divided into two longitudinally.

Parasitic in the thallus of *Ceramium rubrum* and *Cystoclonium purpurascens*. Probably not uncommon.

2. *E. Stilophoræ* Crouan.—Frond 2-5 mm. long; ramuli simple, short; articulations once or twice as long as broad. Sporang. numerous, siliquose, shortly stalked, borne on the branches.

On *Stilophora rhizodes*. Rare; Cornwall and Dorset.

var. *cæspitosa* Rosenv.—Pluriloc. sporang. collected into dense tufts, 4-6 μ in diam., uniseriate. Rare; Dorset.

3. *E. clandestinus* Sauv. (*Elachista clandestina* Crouan).—Filaments simple, 1-2 mm. long, occurring in hemispherical tufts, formed of short assimilating filaments arising from a

cushion-like base, and elongated hairs; assimilating filaments erect or incurved, attenuate at the base, obtuse at the apex; articulations equal in length and breadth, torulose; hairs attenuate at their extremities, articulations 1-4 times as long as broad.

Parasitic in the thallus of various species of Fuci. Very rare; widely distributed.

4. *E. brevis* Sauv. Lat. *brevis*, short.—Endophytic filaments irregularly branched, articulations shorter, or sometimes several times longer than their breadth; external filaments rarely more than 150μ long, articulations equal or once or twice longer than their breadth, simple. Pluriloc. sporang. ovoid or lanceolate, terminal, owing to the presence of a ramulus below the sporangium.

Parasitic in the thallus of *Ascophyllum nodosum*. Rare; Berwick.

5. *E. Valiantei* Born. After R. Valiante, Italian algologist.—Tufts several mm. in diam., forming a gall-like swelling in the thallus of the host; articulations 2-4 times as long as broad in the endophytic portions, which may be swollen at the tips, about equal in length and breadth in the erect filaments; endophytic parts irregularly branched, upright filaments unbranched, terminating in a hair, not attenuate. Pluriloc. sporang. borne terminally or laterally on the erect branches, sessile or stalked, oval or globose, obtuse.

Parasitic on *Cystoseira ericoides*.

6. *E. luteolus* Sauv. Lat. *luteolus*, yellowish.—Occurring in and among the outer cells of the host; much branched at the base, the branches forming a cushion from which the erect filaments arise; erect filaments simple, attenuate upwards, terminating in a hair, articulations 1-3 times as long as broad. Pluriloc. sporang. terminal or lateral, 30-80 mm. long, torulose.

On *Fucus vesiculosus* and *F. serratus*. Probably not uncommon.

Differing from *E. minimus* by the shorter, more torulose sporangia, and in only penetrating the outer layer of the host.

7. *E. minimus* Naeg. Lat. *minimus*, smallest. Small species forming a fringe on the fronds of the host; filaments scarcely 3 mm. long, simple or furnished with a few short branches given off at wide angles. Pluriloc. sporang. irregularly oval or oblong, borne at the apices of the branches.

Parasitic in the receptacles of *Himanthalia lorea* and on *Cladophora rupestris*, *Ceramium rubrum* and other algæ in pools between tide-marks. Very rare; widely distributed.

8. *E. microscopicus* Batt.—In tufts about 3 mm. in diam., branched, articulate, attachment-rhizoids formed from the

lower colourless parts of the filaments ; upper branches fastigiate, assimilating, or bearing colourless hairs which are attenuate at their apices, their articulations being 6 times as long as broad ; articulations near the base of the frond 4-10 times as long as broad, 2-6 times their breadth in the branches, and equal in length and breadth in the ramuli. Sporang. numerous, cylindrical, sessile, borne on the ramuli.

Parasitic in the thallus of *Gracilaria compressa*. Rare ; Dorset.

9. **E. microspogium** Batt. Gr. *mikros*, small, *spongos*, sponge.—Fronds minute, forming yellowish brown, compact, hemispherical, cushion-like patches about 1 mm. in diam., on the fronds of *Ralfsia verrucosa* ; filaments much branched, irregularly nodose and matted together, cylindrical and free above ; branching irregularly dichotomous and spreading below, secund and erect above ; articulations about equal in length and breadth. Pluriloc. sporang. often very numerous, arranged secundly on the upper free branches, oblong-lanceolate, sessile, or borne on very short one- or two-celled stalks. Long colourless hairs present on the upper branches.

Very rare ; Devon.

10. **E. tomentosoides** Farlow *E. tomentosus* and Gr. *eidōs*, like.—Gregarious, covering the host plant with a matted growth, or more scattered, forming patches in the lamina ; filaments about 1 cm. in length, attaining highest development in the spring ; articulations once or twice as long as broad. Pluriloc. sporang. borne in short, numerous, straight or slightly falcate branches, diverging at right angles from the filaments, sessile, linear, generally simple, occasionally pinnate.

On *Laminaria saccharina*. Rare ; Weymouth, North Wales and Cumbræ.

var. **punctiformis** Batt. (*Ascocyclus balticus* Jack non Reinke).—Vegetative filaments erect ; articulations equal in length and breadth or half as long as broad. Rare ; widely distributed.

11. **E. velutinus** Kütz. Lat. *velutinus*, velvety.—Primary filaments in the thallus of the host, erect filaments 0.5-1.5 mm. long, simple or rarely branched ; lower articulations as long as broad, the upper from 1-4 times longer than their breadth. Uniloc. sporang. oval or egg-shaped, sessile or stalked, on the erect portion of the plant.

On the receptacles of *Himanthalia lorea*. Not uncommon.

var. **laterifructus** Batt. Uniloc. sporang. borne laterally and terminally. Very rare ; Plymouth Sound.

12. **E. Battersii** Born. After E. A. L. Batters, British algologist.—Forming lax tufts, 1-2 mm. in height ; erect filaments simple or branched, terminating in a hair ; endophytic filaments forming a layer, one cell thick in the thickened outer wall of the host ; articulations once or twice as long as broad in

the erect filaments, about equal in length and breadth in the procumbent parts. Pluriloc. sporang. ovoid or elongated, sessile or shortly stalked, borne on the erect filaments, or arising from the basal layer; uniloc. sporang. subglobose, borne among the pluriloc. sporang. or on separate filaments.

On *Taonia atomaria*. Very rare; Devon.

13. *E. solitarius* Sauv.—Microscopic; filaments growing below the epidermis of the host or on the surface; external erect filaments short and terminated by a sporangium or long and ending in a hair. Pluriloc. sporang. terminal on short filaments or lateral on long filaments.

On old fronds of *Dictyota dichotoma* and *Desmarestia ligulata*. Rare; South Coast and Ireland.

14. *E. simplex* Crouan. Lat. *simplex*, simple.—Fronde 1 cm. in length; branches few, alternate, occasionally opposite or unilateral; articulations $\frac{1}{2}$ to 3 times as long as broad. Sporang. conical, obtuse, pedicellate.

On *Codium tomentosum*. Not uncommon; widely distributed.

2. NON-PARASITIC SPECIES

15. *E. repens* Reinke. Lat. *repens*, creeping.—Creeping filaments much branched, generally forming a pseudo-parenchymatous layer with irregular outline, one or two plate-like plastids present in each cell; erect filaments short, usually simple. Pluriloc. sporang. arising from the creeping filaments, sessile or shortly stalked, ovate-elongate, hairs present; uniloc. sporang. unknown.

On various algæ, particularly *Polysiphonia* and *Cladophora*, also on *Zostera*. Rare; widely distributed.

var. *confluens* Batt. (*Ascocyclus reptans* Holmes).—On *Chondrus crispus* and *Halidrys siliquosa*. Rare.

16. *E. terminalis* Kütz.—Microscopic, forming cushions 1.5 mm. high on various algæ, irregularly distributed or forming an almost continuous layer; erect filaments simple or somewhat branched; articulations 2–4 times longer than their breadth. Pluriloc. sporang. egg-shaped or elongated, often curved, 50–120 μ long, terminal, or lateral and shortly stalked; uniloc. sporang. oval, 40–50 μ long, terminal.

On *Fucus vesiculosus* and other algæ. Not uncommon.

17. *E. erectus* Kütz.—Tuft about 2 cm. high, sparsely branched; branches erect, 90 μ broad, about 400 μ long; articulations twice as long as broad, hairs present, arising laterally. Pluriloc. sporang. lanceolate, obtuse, sessile, erect, adpressed to the branches.

Very rare; Essex and Northumberland.

18. *E. Holmesii* Batt. After E. M. Holmes, British algologist.—Occurring in tufts on rocks in the shade near high-water

mark, or on woodwork; not more than 1.25 cm. in height, irregularly branched. Pluriloc. sporang. elongated, stalked, borne laterally on the branches; uniloc. sporang. oval or spherical, sessile or shortly stalked.

Rare; South Coast, Berwick and Anglesea (January to June).

19. *E. globifer* Kütz. (*E. insignis* Crouan). Lat. *globus*, a sphere, *fero*, I bear.—In tufts 1–4 cm. in height, branched from the base; branches widely set, alternate or opposite, bearing numerous sporangia. Pluriloc. sporang. ovoid, slightly longer than broad, sessile or borne on a short stalk formed of one articulation.

On *Rhodymenia palmata*. Rather rare; widely distributed.

var. *rupestris* Batt. (*E. simpliciusculus* Ralfs).—On *Stilophora rhizodes* and *Cystoseira ericoides*. Rare; widely distributed.

20. *E. irregularis* Kütz.—In tufts about 5–30 mm. in height, branching diffuse; articulations at the base half as long as broad, in the other parts 4 or more times longer than their breadth. Pluriloc. sporang. egg-shaped or elongated, sessile or rarely shortly stalked, occurring singly or in groups; uniloc. sporang. egg-shaped, sessile.

Epiphytic on Fuci. Very rare; Sussex and Ayr.

21. *E. Sandrianus* Zanard. (*E. elegans* Thur.). After G. B. Sandri, Italian collector.—In tufts 4–12 cm. in height, much branched; branches single or in unilateral series; articulations usually half as long as broad, or equal in length and breadth. Pluriloc. sporang. elongated or egg-shaped, sessile, usually numerous on the inner side of the secondary branches.

Very rare; South Coast and Scotland.

22. *E. Mitchellæ* Harv. (*E. virescens* Thur.). After Miss A. Mitchell, American collector.—Tufts feathery; filaments very slender, much branched; branches and lesser divisions alternate, angles wide, branches and ramuli patent, ramuli attenuate; articulations of the branches 2 or 3 times as long as broad, of the ramuli $1\frac{1}{2}$ times as long as broad. Sporang. elliptic-oblong or linear, sessile and very obtuse, several together.

Rare; Devon, Dorset and Channel Islands.

23. *E. Crouani* Thur. After H. M. and P. L. Crouan, French botanists.—Sparsely branched, branches alternate. Sporang. siliquose, numerous, lower ones often pedicellate, upper ones almost sessile.

On *Scytosiphon lomentarius* and other algæ, on rocks near high-water mark. Rare; widely distributed.

24. *E. confervoides* Le Jol. (*E. siliculosus* Harv.). *Conferva*, a genus of algæ, Gr. *eidōs*, like.—5–50 cm. long, loosely entangled at the base, free and feathery above; branches alternate or

second, attenuate; ramuli small, often terminating in a hair. Pluriloc. sporang. ovate-acute or acuminate, sessile or stalked, often ending in a hair; uniloc. sporang. oval or ellipsoidal.

On wharves and on the larger algæ, frequently fringing *Chorda Filum*. Common and abundant; widely distributed.

A large and variable species, which has been subdivided by Kützinger into a large number of species.

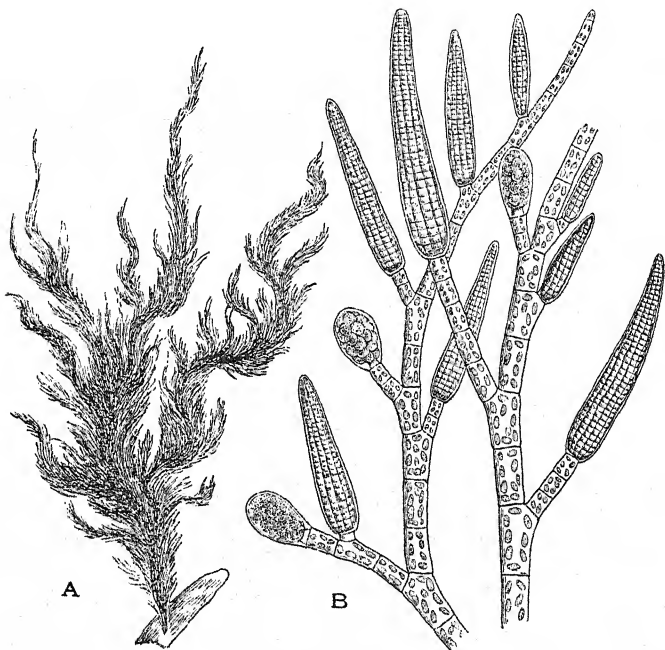


Fig. 70.—*Ectocarpus confervoides* Le Jol. A. ($\times \frac{2}{3}$); B. showing uniloc. and pluriloc. sporangia ($\times 80$).

var. **arctus** Kjellm (*E. arctus* Kütz. and *E. pseudosiliculosus* Crouan).—Pluriloc. sporang. not ending in a hair, $58-75\mu$ by $20-30\mu$. Not uncommon on the leaves of *Zostera marina*.

var. **longipes** Harv.—Pluriloc. sporang. borne on long stalks. Jersey and Cornwall.

var. **hiemalis** Kuck. (*E. hiemalis* Crouan).—Pluriloc. sporang. conical or subacuminate, usually rostrate. Rare; S. England and Dunbar.

var. **subulatus** Hauck (*E. amphibius* Harv.).—Tufts short and loose, with thin elongated pluriloc. sporang. In brackish water. Rare; Bristol, Essex, Norfolk and Cardigan.

25. *E. penicillatus* C. A. Agardh. Lat. *penicillatus*, pencil shaped.—Brown tufts, 10 cm. high, without conspicuous main axes; branching alternate or pseudo-dichotomous, hairs present. Uniloc. sporang. ellipsoidal, rarely egg-shaped, sessile or with a one-celled stalk; pluriloc. sporang. elongated, siliqueose, sessile or shortly stalked, 20–30 μ wide at the base.

On *Scytosiphon lomentarius* and *Chordaria flagelliformis*. Rare; widely distributed.

26. *E. dasycarpus* Kuck. Gr. *dasus*, thick, *karpus*, fruit.—Forming brown tufts 5–7 cm. high; branching pseudo-dichotomous in the main branches, lateral branches alternate. Pluriloc. sporang. cylindrical, sessile or stalked, terminal and lateral on the branches, not ending in a hair, more or less elongated, 10–15 μ broad; uniloc. sporang. unknown. Characterised by the fact that each branch terminates in a pluriloc. sporangium when the plant is in fruit.

Rare; Dorset.

27. *E. fasciculatus* Harv. Lat. *fasciculatus*, clustered.—Filaments 5–20 cm. in length, erect, tufted, entangled below but free and feathery above; articulations of the main branches about as long as broad; secondary branches alternate, short, arising at an obtuse angle; ultimate branches very numerous, secund, ending in a hair; greenish olive to yellowish brown, soft; adhering to paper when young. Pluriloc. sporang. ovate-acuminate or subulate, sessile or on short stalks, borne principally on the upper side of the penultimate branches; uniloc. sporang. oval and sessile.

Not uncommon.

var. *congesta* Crouan (*E. congestus* Crouan and *E. glomeratus* Thur.).—Ramuli borne in clusters near the tips of the branches. Rather rare; widely distributed.

var. *draparnaldioides* Crouan.—On the stipes of *Saccorhiza bulbosa*. Not common; widely distributed.

var. *pygmæus* Batt. (*E. pygmæus* Aresch?).—Smaller than the type. Rare; Bute.

28. *E. tomentosus* Lyngb. Lat. *tomentosus*, woolly.—Fronds composed of numerous matted filaments, 2.5–20 cm. or more in length, sometimes more than 1 cm. in diam. below, much branched; branches alternate or irregular, filiform, simple or bearing smaller branches; ramuli very slender, equal, flexuose, irregularly branched; articulations 2 or 3 times as long as broad, pale olive-green to rusty brown, soft and gelatinous, adhering to paper. Pluriloc. sporang. ovoid or elongated, obtuse, borne on short stalks on the smaller branches.

On *Fucus vesiculosus*, *Himanthalia lorea* and other algae between tide marks, occasionally on rocks and stones. Frequent.

29. *E. ovatus* Kjellm.—Filaments tufted, much branched, 1–3 cm. long, attached by articulated rhizoids, numerous small

plate-like chromatophores in each assimilating cell, branches all terminating in a hair, irregularly alternate, rarely opposite. Pluriloc. sporang. sessile, ovate or more elongated, borne singly or in pairs on the branches; uniloc. sporang. sessile on the branches or intercalary.

Rare; Bute.

var. *arachnoideus* Reinke.—Numerous small lens-shaped chromatophores. Rare; Ilfracombe.

30. *E. Hincksiae* Harv. After Miss Hincks, Irish collector.—Filaments 2.5–5 cm. long, dark olive, somewhat rigid, not matted, irregularly and rather distantly branched; branches clothed with unilateral ramuli, bearing on their inner faces a second series of closely set, subulate smaller ramuli. Sporangia conical, sessile, produced along the inner face of the ramuli, one arising from each articulation, giving the ramulus a serrate appearance. Annual.

Epiphytic on *Saccorhiza bulbosa*. Not common; widely distributed.

31. *E. Reinboldii* Reinke. After T. Reinbold, German collector.—Forming tufts, 10–30 cm. long; filaments branched, branching alternate or pseudodichotomous, branches terminating in a hair with basal growth, intercalary growth in the branches. Pluriloc. sporang. lateral on the branches, sessile, rarely shortly stalked or intercalary, torulose.

On the larger algæ. Very rare; Dorset.

32. *E. distortus* Carm.—Tufts 10–20 cm. long or more, very dense and matted; much branched, irregular, with wide angles, bent at intervals into a zigzag form; smaller branches at right angles or recurved; ramuli scattered, short and spine-like but obtuse; articulations about as long as broad. Sporangia obovoid or ellipsoid, scattered, sessile or slightly stalked. Substance membranous, imperfectly adhering to paper; deep chestnut-brown. Annual.

On the leaves of *Zostera marina*. Very rare; Scotland.

“This species has also been recorded from Torbay and Filey, but it is probable that some variety of *Pilayella littoralis* was mistaken for it” (Batters).

33. *E. Landsburgii* Harv. After the Rev. D. Landsborough, Scottish naturalist.—Filaments capillary, 2.5–5 cm. long, densely entangled in tufts or rolled together in masses, irregularly branched, with numerous branches, spreading at wide angles, dichotomous or alternate; ramuli short, spine-like, horizontal, simple or forked, more or less densely clothing the branches; articulations shorter than their breadth, with thin walls, a character which helps to distinguish the plant from the thick-walled *E. distortus* Carm. Substance tenacious, membranous, not adhering closely to paper; dark brown. Sporangia sessile or stalked.

Dredged in deep water in land-locked bays. Very rare ; Scotland, Ireland and doubtfully from Sidmouth.

34. **E. acanthophorus** Kütz. Gr. *akanthos*, a thorn, *phoreo*, I bear.—Tufts minute, greenish, branched ; filaments about 64μ broad, branching opposite or unilateral ; branches short, acute, spine-like, more or less incurved ; articulations 2-3 times as long as broad in the branches, equal in length and breadth in the ramuli. Sporangia sessile, ovate-lanceolate, obtuse.

Very rare ; Dorset.

35. **E. granulosus** C. A. Agardh.—Filaments tufted, capillary, 10-25 cm. long, much branched, with a central axis and lateral branches unequal in length ; lesser branches usually opposite or rarely alternate, spreading at wide angles, unequal in length ; ramuli opposite or unilateral ; articulations about as long as broad. Pluriloc. sporang. sessile, often borne in a series, ovoid in shape ; uniloc. sporang. sessile, almost spherical. Substance not gelatinous, adhering to paper ; clear olive, yellowish with age. Annual.

On rocks ; on Corallines and other algæ in rock-pools between tide marks. Common and abundant.

36. **E. secundus** Kütz. Lat. *secundus*, following or second.—Small tufts, not more than 2 cm. in height ; branches never opposite. Pluriloc. sporang. similar to those of *E. granulosus* ; uniloc. sporang. unknown.

On rocks and on other algæ. Rare ; widely distributed.

37. **E. fenestratus** Berk. Lat. *fenestratus*, pierced with holes.—Forming small tufts, very slender, 2.5-5 cm. high, not much branched ; branches lying apart and feathery, alternate, repeatedly divided, ultimate ramuli prolonged and straight ; articulations 2-3 times as long as broad in the middle parts, gradually shorter upwards. Pluriloc. sporang. stalked, elliptic-oblong or fusiform, but blunt at the ends. Substance flaccid, adhering to paper, pale greenish olive.

Very rare ; South Coast and Northumberland.

38. **E. Lebelii** Crouan.—Forming small tufts, 1 cm. in diam., branched from the base ; ramuli alternate, rarely opposite ; lower articulations 3 times as long as broad, articulations of the ramuli twice their breadth. Sporang. pedicellate, siliqueose, obtuse.

On *Cystoseira ericoides*. Rare ; Devon and Dorset.

39. **E. Padinæ** Sauv. (*Giffordia Padinæ* Buffham).—Erect filaments 1-3 mm. high, 25μ in diam., attenuate at the base, simple or slightly branched, one or more arising from a short filamentous rhizoid inserted between the cells of the host ; cells of the filaments about twice as long as broad. Uniloc. sporang. ovate-lanceolate, pedicellate, at or near the base of erect filaments. Pluriloc. sporang. elongate-ovate, pedicellate or sessile, at intervals on the erect filaments.

On *Padina Pavonia*. Rare ; Devon.

2. **PILAYELLA** Bory

(After Bachelot de la Pylaie, French algologist.)

Thallus monosiphonous, articulated, much branched, 2–25 cm. long. Uniloc. sporang. formed of from 2–30 contiguous cells; pluriloc. sporang. irregularly cylindrical, variable in size; both kinds of sporang. intercalated in the branches and not on special stichidia as in *Ectocarpus*.

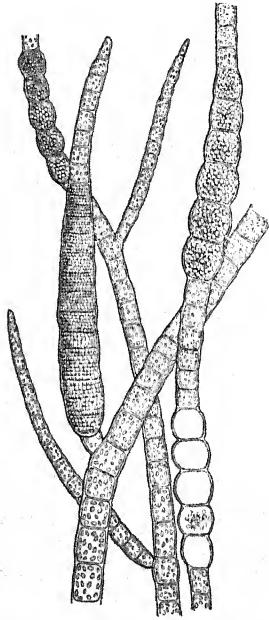


Fig. 71.—*Pilayella littoralis* Kjellm. Showing uniloc. and pluriloc. sporangia ($\times 80$).

P. littoralis Kjellm., var. **opposita** Kjellm. Lat. *litoralis*, belonging to the seashore.—Filaments tufted or irregularly expanded at the base, 5–25 cm. long; branches numerous, usually opposite, given off at wide angles; articulations once or twice longer than broad. Uniloc. and pluriloc. sporang. intercalary. Gelatinous, adhering to paper.

Common.

var. **brachiata** Batt.—Finely tufted, feathery, much branched; branches opposite or quaternate; ramuli opposite, very patent. Rare; Norfolk.

var. **longifructus** Batt.—Pluriloc. sporang. elongate and attenuate upwards. Rare; Devon, Durham, Northumberland and Scotland.

var. **firma** Kjellm.—Pluriloc. sporang. forming spindle-like rows, intercalary. Common and abundant.

var. **ramellosa** Kuck.—Multiloc. sporang. developed in the middle of the branchlets. Padstow.

Although the above varieties have been recorded, the successive phases of the plant exhibit so much fluctuation that it is doubtful whether they can be regarded as more than growth forms.

3. **MIKROSYPHAR** Kuck.(Gr. *mikros*, small, and *suphar*, wrinkled skin.)

Thallus consisting of monosiphonous branched creeping filaments, sometimes scattered, sometimes united into a pseudo-parenchymatous tissue; vegetative cells generally twice as

long as broad, with one or two plate-like chromatophores; hairs present or absent. Reproduction by uniloc. and pluriloc. sporangia.

Key.

Epiphytic on species of *Porphyra* *M. Porphyrae*.
Epiphytic on *Polysiphonia urceolata* *M. Polysiphoniae*.

M. Porphyrae Kuck.—Forming brown patches on species of *Porphyra*.

Probably not uncommon; Kent.

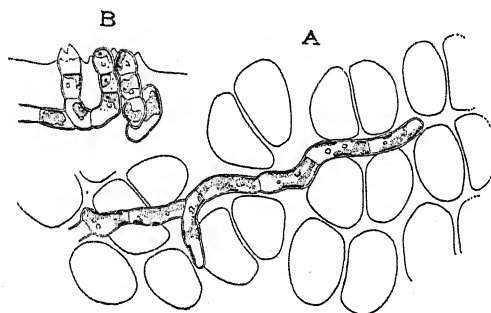


Fig. 72.—*Mikrosyphar Porphyrae* Kuck. A. Creeping among cells of host ($\times 600$); B. sporangia ($\times 600$). (After Kuckuck.)

M. Polysiphoniae Kuck.—Forming microscopic brown patches on the thallus of *Polysiphonia urceolata*.

Probably not uncommon; Northumberland.

4. **PHÆOSTROMA** Kuck.

(Gr. *phaios*, brown, and *stroma*, a mattress.)

Thallus epiphytic, consisting of monosiphonous branched filaments, scattered or united into a disc of cells, which may be divided by horizontal walls; chromatophores polygonal and plate-like; hairs with basal growth. Uniloc. and pluriloc. sporangia.

P. pustulosum Kuck.—Thallus epiphytic, creeping or forming a disc of irregular filaments. Pluriloc. and uniloc. sporang. sometimes on the same, sometimes on different individuals.

Epiphytic on *Zostera*, *Scytosiphon lomentarius*, *Chorda tomentosa*, and *Laminaria* spp. Probably not uncommon; Devon, Northumberland and Bute.

P. prostratum Kuck.—Thallus of irregular outline, formed of a single layer of cells near the edge, 2 or rarely 3 strata in the

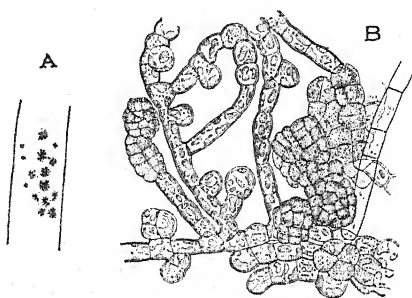


Fig. 73.—*Phæostroma prostratum* Kuck. A. ($\times \frac{3}{8}$); B. showing sporangia ($\times 270$). (After Kuckuck.)

middle; vegetative cells ellipsoidal, sometimes round or polygonal. Uniloc. sporang. formed from the cells of the upper stratum.

5. SYMPHYOCARPUS Rosenv.

(Gr. *sumphuo*, I unite, and *karpus*, a fruit.)

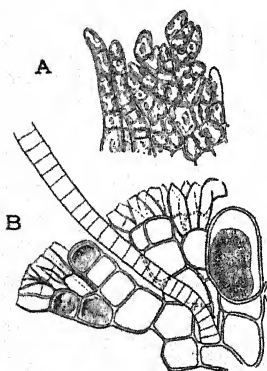


Fig. 74. — *Symphyocarpus strangulans* Rosenv. A. ($\times 130$); B. showing sporangia ($\times 330$). (After Rosenvinge.)

Thallus encrusting, formed of a basal layer and upright filaments; basal layer consisting of irregularly branched filaments, free or united; upright filaments short, of equal length, simple or falsely dichotomously branched. Pluriloc. sporangia formed at the tips of erect filaments.

S. strangulans Rosenv.—Epi-phytic on *Chaetomorpha melagonium* Kütz. Cells of the basal filaments as long, or $\frac{1}{2}$ as long, as broad; upright filaments almost cylindrical, formed of from 2–7 cells which are almost as long as broad; hyaline hairs present at intervals.

Rare; Northumberland and Cumbrae.

6. LITHODERMA Aresch.

(Gr. *lithos*, a stone, and *derma*, skin.)

Thallus encrusting, horizontally expanded, the lower part adhering to the substratum and bearing erect branches on which the uniloc. and pluriloc. sporangia occur in somewhat indefinite sori.

Key.

Chromatophores single in the cell, plate-like *L. simulans*.
More than one lens-shaped chromatophore in each cell ... *L. fatiscens*.

L. fatiscens Aresch. Lat. *fatiscens*, cracking.—Forming round or irregular dark olive-brown patches; basal layer several cells thick bearing upright filaments; chromatophores lens-shaped, more than one in each cell. Uniloc. sporang. spherical or oval, with a gelatinous wall, borne at the apices of the erect branches; pluriloc. sporang. elongated and club-shaped, simple or occasionally branched, enclosed in a thick gelatinous wall; uniloc. and pluriloc. sporang. on different plants.

On rocks, stones, shells and on other algæ, in the sublittoral region and to a depth of 12 fathoms; Devon, Wales and Isle of Cumbrae.

L. simulans Batt. (*Sorapion simulans* Kuck.).—Frond microscopic, brown, encrusting, erect filaments arising from the basal layer, branched, united into a pseudoparenchyma; chromatophores single in the cell, plate-like. Uniloc. sporang. pear-shaped, borne in small groups on the thallus; pluriloc. sporang. unknown.

On stones, sometimes associated with *L. fatiscens*. Rare; Devon.

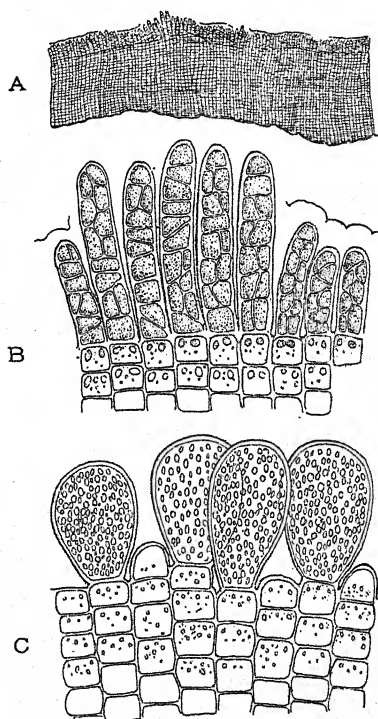


Fig. 75.—*Lithoderma fatiscens* Aresch. A. Sect. of thallus ($\times 90$); B. pluriloc. sporangia ($\times 600$); C. uniloc. sporangia ($\times 600$).

7. STREBLONEMA Derb. & Sol.

(Gr. *streblos*, twisted, and *nema*, a thread.)

Primary branches procumbent, creeping in or upon other algæ or alcyonidia; secondary branches erect; thallus microscopic. Uniloc. sporang. spherical or oval; pluriloc. sporang. legume-shaped, simple or branched.

Key.

Endozoic in <i>Alcyonidium</i> spp.	<i>S. infestans</i> (3).
Endophytic in algæ	
In the thallus of <i>Dudresnaya verticillata</i>	<i>S. volubile</i> (9).
In the thallus of <i>Chorda Filum</i>	<i>S. æquale</i> (4).
In the thallus of <i>Chylocladia kaliformis</i>	<i>S. Zanardini</i> (6).
In the thallus of <i>Petocelis cruenta</i>	<i>S. helophorus</i> (7).
In the thallus of <i>Brongniartella byssoides</i>	<i>S. intestinum</i> (1).
Pluriloc. sporang. more or less branched, legume shaped	<i>S. fasciculatum</i> (2).
Pluriloc. sporang. simple, filamentous; occurring in <i>Mesogloia Griffithiana</i>	<i>S. tenuissimum</i> (10).
Uniloc. sporangia spherical	<i>S. sphaericum</i> (8).
Uniloc. sporangia oval	<i>S. Chordariæ</i> (5).

1. *S. intestinum* Holm. & Batt. (*Etonema intestinum* Reinsch).—Thallus formed of a system of filaments found between the cells of the host; external hairs absent; filaments alternately or irregularly branched, sometimes bifurcating. Pluriloc. sporang. produced externally, simple, acutely ovoid.

Immersed in the cortical layers of *Brongniartella byssoides*. Very rare; Weymouth.

2. *S. fasciculatum* Thur. Lat. *fasciculatus*, clustered.—Filaments 8–12 μ thick, irregularly branched; articulations once or twice longer than their breadth. Pluriloc. sporang. more or less branched, legume-shaped.

Immersed among the cortical filaments of *Castagnea virescens*. Dorset, Northumberland, Wales, Scotland and Channel Islands.

var. *simplex* Batt.—Immersed between the cortical filaments of *Helminthora divaricata* and *Castagnea virescens*. Rare.

3. *S. infestans* Batt. (*Endodictyon infestans* Gran.). Lat. *infestans*, attaching.—Filaments repeatedly branched; articulations 1–3 times as long as broad. Endozoic in species of *Alcyonidium*.

Rare; Southsea.

4. *S. æquale* Oltm. Lat. *æqualis*, equal.—Filaments equal in length to the limiting layer of the host. Pluriloc. sporang. obovoid or obcordate.

Immersed in the cortical layer of *Chorda Filum*. Probably not uncommon. Devon, Dorset, Hants and Cumbrae.

5. *S. Chordariæ* Cotton (*Dichosporangium Chordariæ* Wolny).

—Filaments much branched, irregularly nodose; hairs and fertile branches erect, the former projecting above the surface. Uniloc. sporang. on short stalks, solitary or clustered, oval; pluriloc. sporang. unknown.

Immersed in the fronds of various algæ, particularly *Chordaria flagelliformis*, usually accompanied by *Bulbocoleon*.

6. **S. Zanardinii** Batt. (*Ectocarpus Zanardinii* Crouan). After G. Zanardini, Italian botanist.—External filaments few. Pluriloc. sporang. protruding from the host and frequently forked.

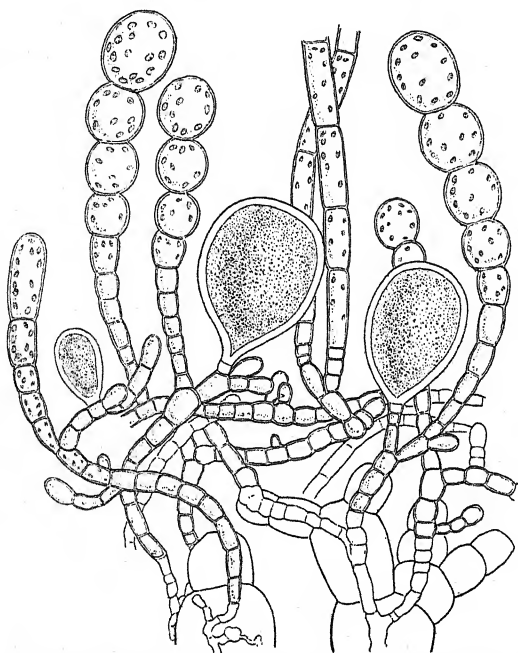


Fig. 76.—*Streblonema sphaericum* Thur. Filaments with uniloc. sporangia ($\times 300$).

In the cortical layer of *Chylocladia kaliformis*. Probably not uncommon. S. England, Isle of Wight, Guernsey and Cumbræ.

7. **S. helophorus** Batt. (*Ectocarpus helophorus* Rosenv.). Gr. *helos*, a marsh.

Immersed in the fronds of *Petrocelis cruenta*. Rare; Berwick and Cumbræ.

8. **S. sphaericum** Thur.—Filaments $10-15\mu$ thick, irregularly branched. Uniloc. sporang. spherical, $35-40\mu$ in diam., sessile or on a short stalk; pluriloc. sporang. ovoid, acute, stalked, often containing only one row of zoospores.

Occurring between the cortical filaments of *Mesogloia vermiculata*. Probably not uncommon; Dorset, Anglesey and Scotland.

9. *S. volubile* Thur. Lat. *volubilis*, twining.—Pluriloc. sporang. roundish or spindle-shaped, $20-75\mu$ by $18-21\mu$.

Creeping between the cortical filaments of *Dudresnaya verticillata*. Very rare; Devon and Dorset.

10. *S. tenuissimum* Hauck. Lat. *tenuissimus*, thinnest.—Filaments $4-8\mu$ thick, irregularly branched, articulations 2-6 times longer than broad. Pluriloc. sporang. filamentous, simple.

Creeping between the cortical filaments of *Mesogloia Griffithsiana*. Rare; Devon, Dorset and Wales.

8. SOROCARPUS Pringsh.

(Gr. *soros*, a heap, and *karpos*, a fruit.)

Thallus composed of branched articulated filaments, ending in elongated colourless hairs. Pluriloc. sporang. rounded,

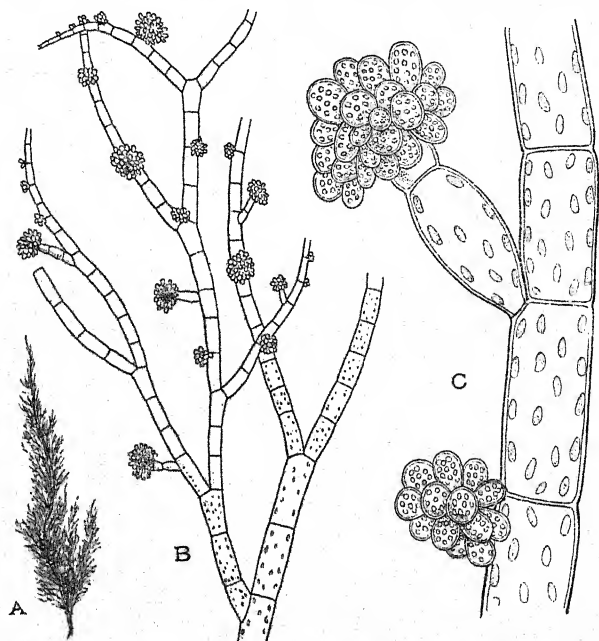


Fig. 77.—*Sorocarpus uvæformis* Pringsh. A. ($\times \frac{2}{3}$); B. showing pluriloc. sporangia ($\times 60$); C. ($\times 300$).

borne in dense clusters often on a unicellular filament, sometimes arising at the base of a branchlet.

S. uvæformis Pringsh. Lat. *uva*, a bunch of grapes, *forma*, shape.—Occurring in large or small tufts; filaments $20-50\mu$

thick; articulations $1\frac{1}{2}$ to 3 times as long as broad. Pluriloc. sporang. almost sessile or borne on a short filament.

On larger algæ. Very rare; Dorset, Cumbrae, Renfrew and Clare Island.

Family II.—ELACHISTEACEÆ

Cushion-forming plants, characterised by the absence of colourless hairs, as in the Corynophlœaceæ. These are replaced by long assimilating filaments or analogous organs, which may be short and club-shaped or elongated. Reproduction by uniloc. and pluriloc. sporangia borne on the branches.

1. LEPTONEMA Reinke

(Gr. *leptos*, narrow, and *nema*, a thread.)

Forming a tuft on other algæ, the filaments interwoven at the base, spreading above; erect filaments unbranched; growth

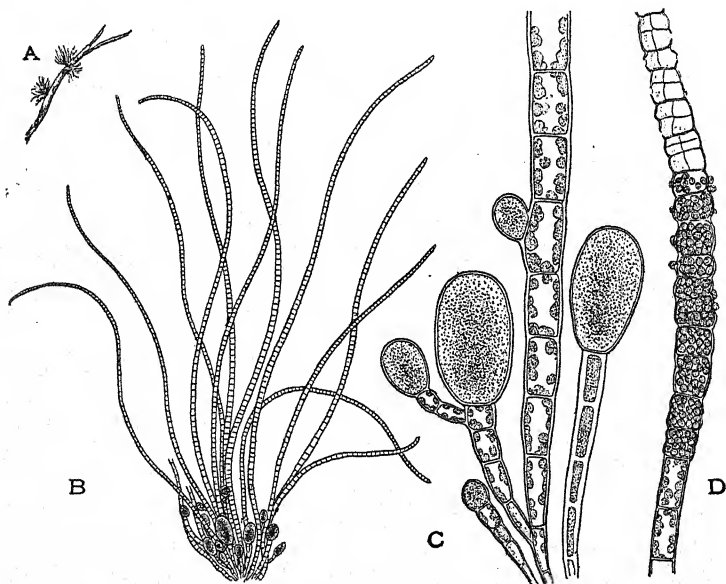


Fig. 78.—*Leptonema fasciculatum* Reinke. A. ($\times 1$); B. ($\times 60$); showing uniloc. sporangia ($\times 300$); D. pluriloc. sporangia ($\times 300$).

intercalary from the base of the filament. Uniloc. sporang. formed at the base near the meristematic zone; pluriloc. sporang. formed near the apex of the filaments, intercalary.

L. fasciculatum Reinke, var. *subcylindrica* Rosenv. Lat. *fasciculatus*, clustered.—Sterile filaments $7-12\mu$ thick, fertile

filaments 7-16 μ thick. Uniloc. sporang. elongated, lateral, at the base of the filaments; pluriloc. sporang. intercalary, near the apex, ovoid.

At low-water mark and sublittorally to a depth of 4 fathoms on *Laminaria* spp., *Alaria esculenta*, other algæ, and *Zostera*. Very rare; Bangor, Scotland and Clare Island.

var. *uncinatum* Reinke.—Filaments curved. Very rare; Gourock.

2. HALOTHRIX Reinke

(Gr. *hals*, the sea, and *thrix*, a hair.)

Development similar to that of *Leptonema*, but with branched erect filaments and intercalary growth; lower part consisting of short interwoven filaments, forming an organ of attachment,

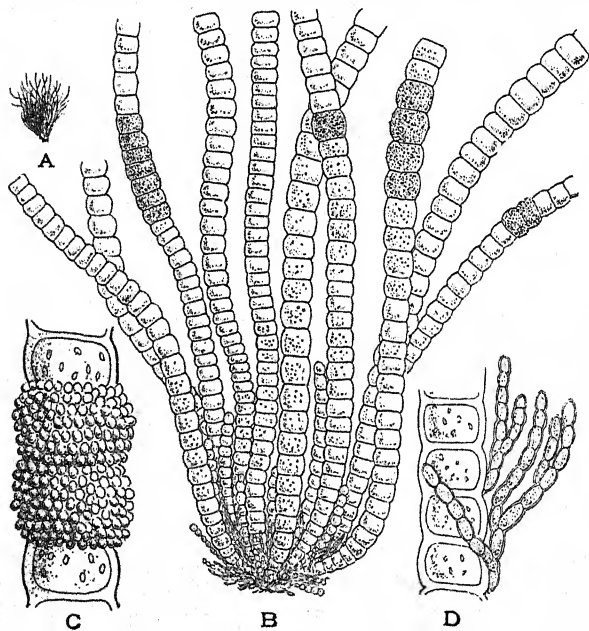


Fig. 79.—*Halothrix lumbricalis* Reinke. A. ($\times 1$); B. Portion of plant ($\times 130$)—note branches at the base; C. Cluster of pluriloc. sporangia ($\times 250$); D. basal branches ($\times 200$).

erect portion of long assimilating filaments bearing short much-branched filaments near their bases.

H. lumbricalis Reinke. Lat. *lumbricalis*, worm-shaped.—Epiphytic, monosiphonous; articulations about equal in length and breadth. Uniloc. sporang. unknown; pluriloc. sporang. in

clusters at the apices of short horizontal filaments intercalary in development, densely packed at intervals on the long assimilating branches.

Rare; widely distributed.

3. ELACHISTEA Duby

(Gr. *elachistos*, very small.)

Fronds olive-brown, tufted or pulvinate; basal portion solid, somewhat parenchymatous, composed of densely branched filaments becoming free at the surface; branching corymbose, forming a layer of paraphyses, at the base of which the sporangia and a series of long exserted filaments are borne; hairs formed at the base of the paraphyses. Uniloc. sporang. rhombic-ovoid; pluriloc. sporang. cylindrical, composed of a few cells in a linear series.

Key.

- | | |
|-------------------------------------------------------------|--------------------------|
| 1. Epiphytic on Fucaceæ | 2. |
| Epiphytic on other algæ | 3. |
| 2. Forming oblong swellings on the fronds of | |
| <i>Himanthalia lorea</i> | <i>E. scutulata</i> (5). |
| Occurring on other Fuci | 4. |
| 3. Epiphytic on <i>Cladophora rupestris</i> | <i>E. Grevillei</i> (3). |
| Forming almost spherical gelatinous tufts on | |
| <i>Arthrocladia villosa</i> and other algæ | <i>E. stellaris</i> (1). |
| 4. Brush-like tufts 2.5 cm. in length on <i>F. serratus</i> | |
| and <i>F. vesiculosus</i> | <i>E. fucicola</i> (2). |
| Small tufts about 1 cm. in height on <i>Cystoseira</i> | |
| and <i>Halidrys</i> | <i>E. flaccida</i> (4). |

1. **E. stellaris** Aresch. Lat. *stellaris*, starry.—Forming almost spherical gelatinous tufts, 1–3 mm. in diam. on *Arthrocladia villosa*; basal layer very small, free filaments 15–35 μ thick; lower articulations about as long as broad, upper ones 2–4 times longer than their breadth.

Devon, Dorset and Wales.

var. **Chordæ** Aresch.—Epiphytic on *Chorda Filum*, *Asperococcus bullosus*, *Cutleria multifida*, *Spermatocnusus paradoxus*, and *Mesogloia Griffithsiana*. Rare; widely distributed.

2. **E. fucicola** Fries. *Fucus*, a genus of algæ, Lat. *colo*, I inhabit.—Tufted, 2.5 cm. long; olive-green, becoming brown; basal portion distinct, subglobose; exserted filaments about 0.05 mm. broad, attenuate at the base, obtuse at the apex; articulations of the basal portion broader than long below, becoming longer above; paraphyses recurved, clavate. Uniloc. sporang. long, pyriform or obovoid-rhombic.

Common and abundant, particularly on Fuci.

3. **E. Grevillei** Arnott. After R. K. Greville, Scottish cryptogamist.—Epiphytic on *Cladophora rupestris* between the

tide-marks, often in places exposed to the drip of fresh water. May to September.

Rare; Berwick and Scotland.

4. *E. flaccida* Aresch. (incl. *E. curta* Aresch.).—Dense tufts of free, simple, greenish olive, sometimes yellowish, filaments, markedly attenuate at the base, arising from a basal hemispherical tubercle composed of vertical branching fibres, closely combined

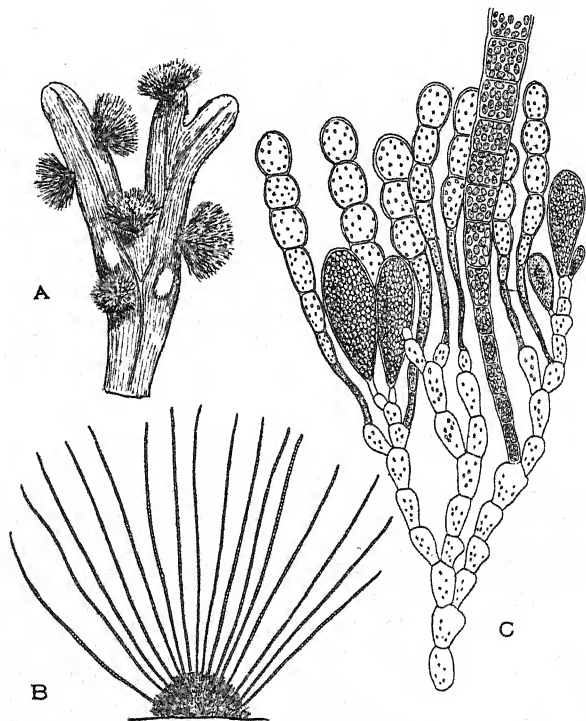


Fig. 80.—*Elachistea fucicola* Fries. A. ($\times \frac{3}{4}$); B. ($\times 9$); C. showing uniloc. sporangia ($\times 130$).

into a cartilaginous mass; lower articulations half as long as broad, upper ones equal in length and breadth; paraphyses numerous, linear-clavate, arising from the base between the simple filaments. Uniloc. sporang. obovoid on slender short pedicels. Texture flaccid; adhering to paper.

On *Cystoseira* and *Halidrys*. Not uncommon.

5. *E. scutellata* Duby. Lat. *scutellatus*, shaped like a small platter.—Tubercles forming oblong swellings on the fronds of *Himanthalia*; 1.25 to 5 cm. or more in length, from 0.5 to

1.25 cm. thick; colonies extending along the edge of a thong, occupying its surface, or encircling it; tubercle solid and cartilaginous, composed of dichotomous hyaline filaments with pyriform cells; apices of branching filaments bearing paraphyses and long free simple filaments; articulations about three times as long as broad. Uniloc. sporang. oval, obtuse at both ends, borne on long pedicels. Articulations about three times as long as broad. Texture cartilaginous, with slimy surface.

Not uncommon; widely distributed.

4. *GIRAUDIA* Derb. & Sol.

(After H. Giraudy, French naturalist.)

Thallus monosiphonous at the base, polysiphonous in the upper parts; much branched, articulated throughout, apices often ending in a bunch of colourless hairs. Pluriloc. sporang.

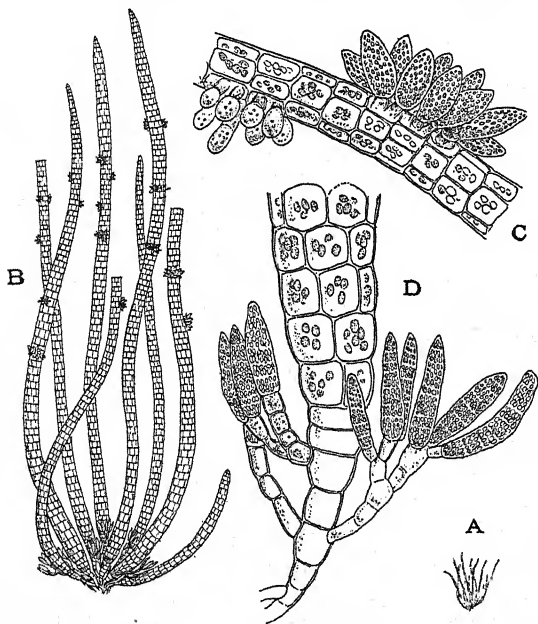


Fig. 81.—*Giraudia sphacelarioides* Derb. & Sol. A. ($\times 1$); B. ($\times 30$); C. showing uniloc. sporangia ($\times 300$); D. showing pluriloc. sporangia ($\times 300$).

elongated, on simple or branched lateral filaments, borne in clusters at the base of polysiphonous branches; uniloc. sporang. in dense patches, sessile, on the polysiphonous parts of the frond.

G. sphacelarioides Derb. & Sol. *Sphacelaria*, a genus of

algæ, *Gr. eidos*, like.—In tufts 5–15 mm. high; thallus attached by rhizoids to the substratum, consisting of elongated simple, polysiphonous branches, 30–80 μ thick, often bearing colourless hairs at their apices. Growth trichothallic, not from an apical cell. Uniloc. and pluriloc. sporang. borne on the branches.

On *Cystoseira*, other algæ and *Zostera*. Rare; South Coast, I. of Wight and Ireland.

Family III.—SPOROCHNACEÆ.

Thallus terete or flat, parenchymatous, solid or hollow. Uniloc. and pluriloc. sporangia on or among articulated ramuli, forming wart-like sori encircling the thallus or at the apices of the branchlets.

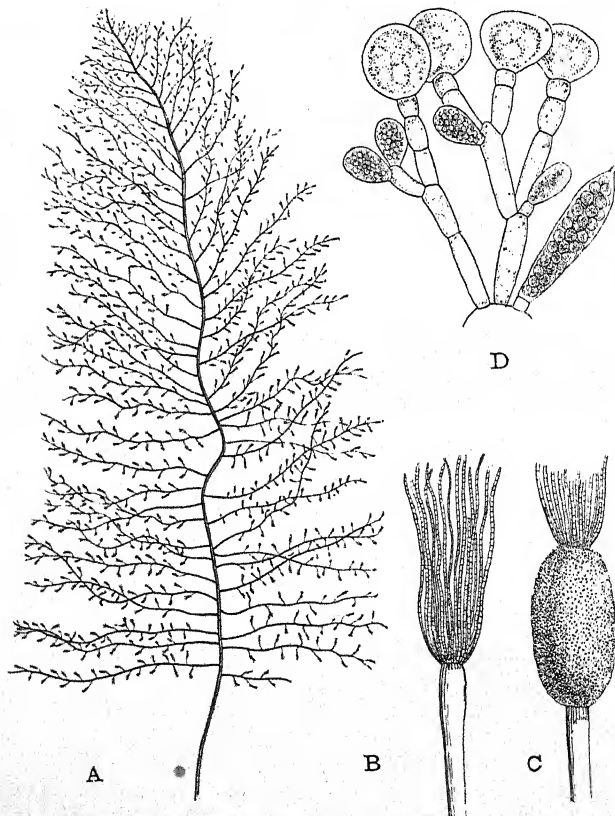


Fig. 82.—*Sporochnus pedunculatus* C. A. Agardh. A. ($\times \frac{1}{3}$); B. young receptacle ($\times 30$); C. mature receptacle ($\times 30$); D. Trans. sect. of receptacle showing uniloc. sporangia ($\times 416$).

1. SPOROCHNUS C. A. Agardh

(Gr. *spora*, a seed, and *chnoos*, wool.)

Thallus filamentous, alternately branched, formed of an inner layer of large cells and an outer layer of small assimilating cells. Uniloc. sporang. club-shaped, borne laterally on monosiphonous branched filaments, crowded together on large oval or elongated receptacles, bearing a cluster of hairs at their apices.

S. pedunculatus C. A. Agardh. Lat. *pedunculatus*, stalked.—15-45 cm. long, terete, clear olive colour, smooth, with lateral branches margined with receptacles, which are sessile when young, stalked when adult; receptacle consisting of a slender axis, round which numerous monosiphonous branched filaments are whorled; cartilaginous, adhering to paper. Uniloc. sporang. borne laterally on the filaments.

On submarine rocks and shells near low-water mark and at greater depth. Rare; widely distributed.

2. CARPOMITRA Kütz.

(Gr. *karpos*, fruit, and *mitra*, a head-dress.)

Frond filiform or compressed, solid, alternately or pseudo-dichotomously branched. Uniloc. sporang. borne at the base of branched monosiphonous filaments, crowded together on a mitre-like receptacle.

Sauvageau has shown that an alternation of generations exists in *Carpomitra*. The spores from the unilocular sporangium germinate to form monœcious prothalli on which minute conical antheridia are borne, either isolated or in groups, together with oogonia formed in the swollen terminal cells. Fertilisation has not been observed, but from the oogonium a pro-embryo develops on which ultimately a new *Carpomitra* plant is borne.

C. costata Batt. (*Fucus costatus* Stackh. and *Carpomitra Cabrerae* Kütz.). Lat. *costatus*, ribbed.—15-20 cm. long, much branched, light brown; branching irregularly dichotomous, compressed, midrib more or less prominent; branches erect

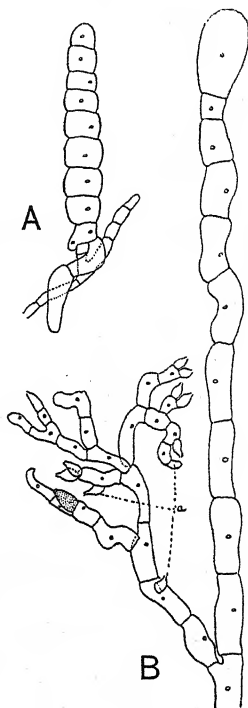


Fig. 83.—*Carpomitra costata* Batt. A. Pro-embryo with rhizoid showing its development on the prothallus ($\times 160$); B. Prothallus with antheridia (a) and also a swollen cell terminating a filament, probably a future oogonium ($\times 440$). (After Sauvageau.)

with acute axils, attenuate at the base, obtuse at the apex.
Uniloc. sporang. formed at the bases of branched monisiphonous

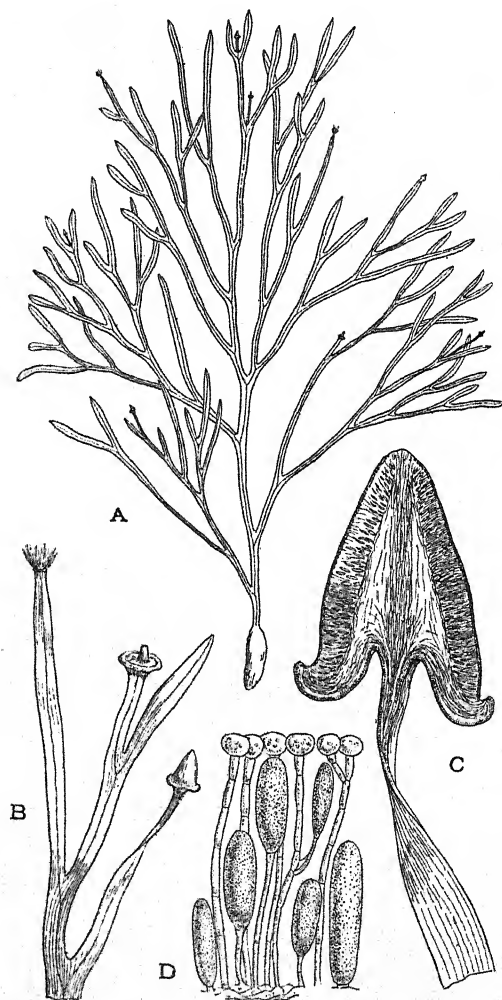


Fig. 84.—*Carpomitra costata* Batt. A. ($\times \frac{2}{3}$); B. showing receptacles ($\times 4$); C. section of receptacle ($\times 16$); D. Sporangia ($\times 300$).

filaments, developed on receptacles which are formed on the thickened apices of the branch midribs.

Very rare; S. England, Jersey and Ireland.

Family IV.—CORYNOPHLÆACEÆ

Differing from Mesogloiaceæ in that the thallus is encrusting, cushion-like or spherical, and not an elongated axis. Uniloc. and pluriloc. sporangia developed, similarly to those of the Mesogloiaceæ.

1. **MICROCORYNE** Strömf.

(Gr. *mikros*, small, and *corune*, a club.)

Fronds very minute, composed of a central axis of colourless filaments rather loosely united into a solid mass; peripheral

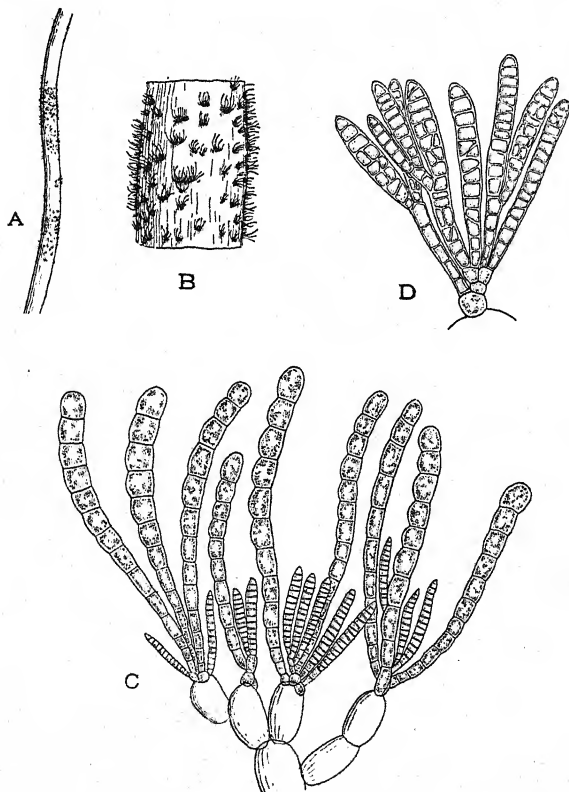


Fig. 85.—*Microcoryne ocellata* Strömf. A. on host ($\times \frac{3}{8}$); B. ($\times 8$); C. showing pluriloc. sporangia ($\times 300$); D. sporangia ($\times 430$).

layer of short horizontal filaments packed in a gelatinous substance. Pluriloc. sporang. cylindrical or spindle shaped, crowded at the bases of the unchanged filaments of the peripheral layer.

M. ocellata Strömf. Lat. *ocellatus*, with a little eye.—Fronds 2–5 mm. long, simple and clavate or shortly forked. Pluriloc. sporang. formed by the transformation of the peripheral filaments; divisions of the sporangium simple at the base and apex, but longitudinally bisected.

On *Castagnea Griffithsiana* and *Chorda Filum*. Very rare; Ferry Bridge, near Weymouth.

2. PETROSPONGIUM Naeg.

(Gr. *petros*, a rock, and *spongos*, a sponge.)

Thallus forming a more or less hemispherical, solid, gelatinous mass, inner parts consisting of anastomosing branched filaments, continued outwards in dichotomous, bushy, gelatinous branches. Uniloc. sporang. at the base of the peripheral branches, elongated, shortly stalked; pluriloc. sporang. unknown.

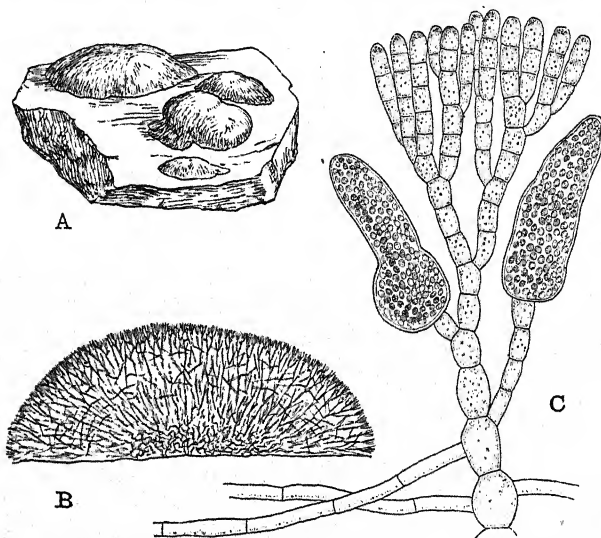


Fig. 86.—*Petrospongium Berkeleyi* Naeg. A. ($\times \frac{3}{8}$); B. section of thallus ($\times 16$); C. showing uniloc. sporangia ($\times 300$).

P. Berkeleyi Naeg. (*Leathesia Berkeleyi* Harv.). After the Rev. M. J. Berkeley, British cryptogamist.—Thallus hemispherical or irregularly expanded; olive-brown, gelatinous, 5–20 mm. in width, peripheral filaments 10–15 μ thick; articulations once or twice as long as broad. Uniloc. sporang. large, elongated, cylindrical, borne laterally on the filaments.

On rocks and encrusting algæ such as *Ralfsia verrucosa* between tide-marks. Rare; southern coasts.

3. **LEATHESIA** S. F. Gray

(After the Rev. G. R. Leathes, British naturalist.)

Forming irregularly globose masses, solid when young, soon becoming hollow; internal portion composed of radiating, dichotomous filaments, the terminal ones bearing short, simple, densely packed, assimilating filaments. Sporangia and hairs borne at the base of the outer filaments; pluriloc. sporang. cylindrical, composed of few cells in a single row; uniloc. sporang. pyriform or ovoid.

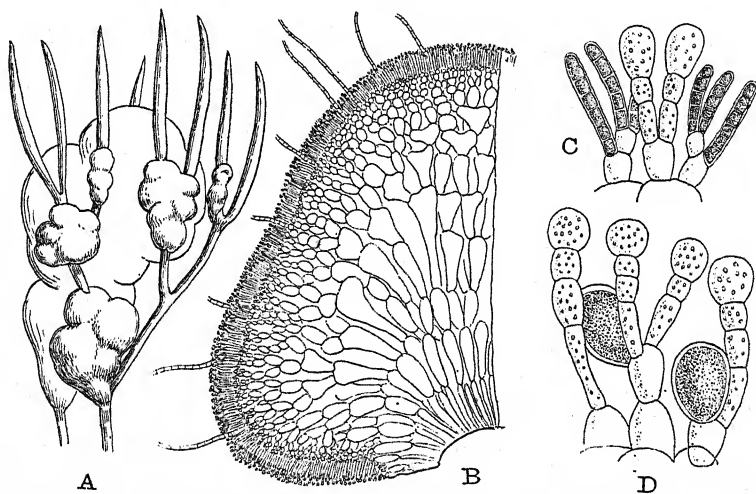


Fig. 87.—*Leathesia difformis* Aresch. A. on host ($\times \frac{1}{3}$); B. section of thallus ($\times 30$); C. pluriloc. sporangia ($\times 420$); D. uniloc. sporangia ($\times 420$).

L. difformis Aresch. (*L. tuberiformis* S. F. Gray).—Fronds 1.25–5 cm. diam., solitary or aggregated, at first globose and solid, becoming irregularly lobed and hollow; brownish olive, cartilaginous. Pluriloc. and uniloc. sporang. borne terminally or laterally on the outer club-shaped filaments. Annual.

Between tide-marks on rocks, corallines and smaller algæ. Very common; widely distributed.

Subgenus **Corynophloea** Kütz.

L. crisa Harv.—Forming cushions on other algæ; elongated dichotomous branches arising from basal filaments which are continued in much-branched, bushy, club-shaped filaments and elongated hairs. Uniloc. sporang. borne laterally on the club-shaped bushy branches.

Very rare; Cumbræ and Alderney.

4. MYRIACTIS Kütz.

(Gr. *muri*os, countless, and *aktis*, a ray.)

Similar to *Elachistea*, but having no exerted assimilating filaments, although elongated colourless hairs may be present, and differing by the development of the sporangia in transformed cells of the assimilating filaments.

Key.

- | | |
|-----------------------------------------------------------------------------------|----------------------------|
| 1. Paraphyses incurved | 2. |
| Paraphyses straight | 3. |
| 2. Cells of the paraphyses equal in length and breadth throughout | <i>M. pulvinata</i> (1). |
| Cells of the paraphyses twice as long as broad near the base, squarish above..... | <i>M. Areschougii</i> (2). |
| 3. Unilocular sporangia moniliform..... | <i>M. Haydeni</i> (4). |
| Unilocular sporangia borne singly | <i>M. stellulata</i> (3). |

1. *M. pulvinata* Kütz. (*Elachista attenuata* Harv.). Lat. *pulvinatus*, cushion-shaped.—Tufts minute, globose, olive-green, originating in a minute tubercle, which ramifies into the host; cushion consisting of a basal portion, giving off lateral filaments which penetrate the substratum, and slightly curved, fusiform paraphyses attenuate at the base; cells of the paraphyses about equal in length and breadth. Pluriloc. sporang. very numerous, borne laterally at the base of the paraphyses, cylindrical; uniloc. sporang. stalked, borne laterally on the paraphyses. Annual.

Epiphytic on the fruiting branches of *Cystoseira ericoides*, and *Halidrys siliquosa*. Not uncommon; widely distributed.

2. *M. Areschougii* Batt. (*Elachista Areschougii* Crouan). After J. E. Areschoug, Swedish algologist.—Tufts minute, hemispherical, scarcely larger than a pin's head, the basal layer consisting of colourless cells from which arise incurved paraphyses, attenuate at the base, obtuse at the apex; articulations twice as long as broad below, squarish above; colourless hairs present, much longer than the paraphyses, articulations 3–4 times as long as broad. Sporang. clavate, attached at the base of the incurved filaments.

On the thongs of *Himanthalia*. Rare; Northumberland, Scotland and Ireland.

3. *M. stellulata* Batt. (*Elachista stellulata* Griff.). Lat. *stellulatus*, with little stars.—Tufts very minute, stellate; tubercle well developed, composed of large colourless cells, dichotomously branched, with elongated hairs and club-shaped paraphyses arising from the apices of the branches. Sporang. borne laterally or terminally on the paraphyses.

On *Dictyota dichotoma*. Rare; widely distributed.

4. **M. Haydeni** Batt. (*Elachista Haydeni* Gatty, *E. moniliformis* Foslie). After the Rev. F. W. Hayden, British collector. —Tufts minute, paraphyses thickest a little above the base,

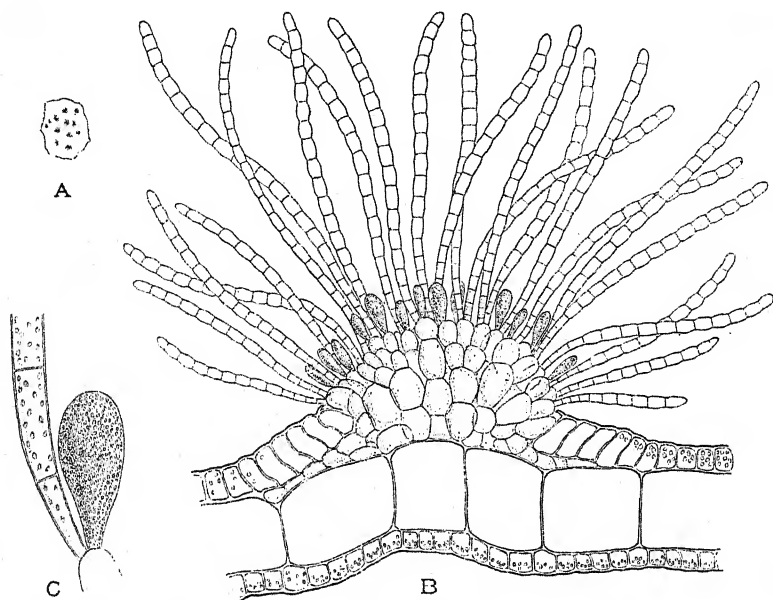


Fig. 88.—*Myriactis stellulata* Batt. A. Colonies on host ($\times 3$); B. Section of colony and host ($\times 130$); C. uniloc. sporangia ($\times 430$).

attenuate towards the apex; articulations once or twice as long as broad. Pluriloc. sporang. unbranched, densely crowded, almost linear, stalked; uniloc. sporang. moniliform, terminal on erect filaments.

On *Scytosiphon lomentarius*. Rare; northern England.

Family V.—MESOGLOIACEÆ.

Fronds cylindrical, branching, usually gelatinous, consisting of an axis of longitudinal filaments, and a cortex of densely packed sub-spherical cells. Sporangia borne among the cortical cells or formed directly from them.

1. **BUFFHAMIA** Batt.

(After T. H. Buffham, British algologist.)

Fronds solitary or gregarious, attached to the host by rhizoidal filaments, more or less gelatinous, assimilatory filaments

cylindrical or club-shaped. Pluriloc. sporang. linear-oblong or spindle-shaped, stalked, as long as, or shorter than, the assimilatory filaments.

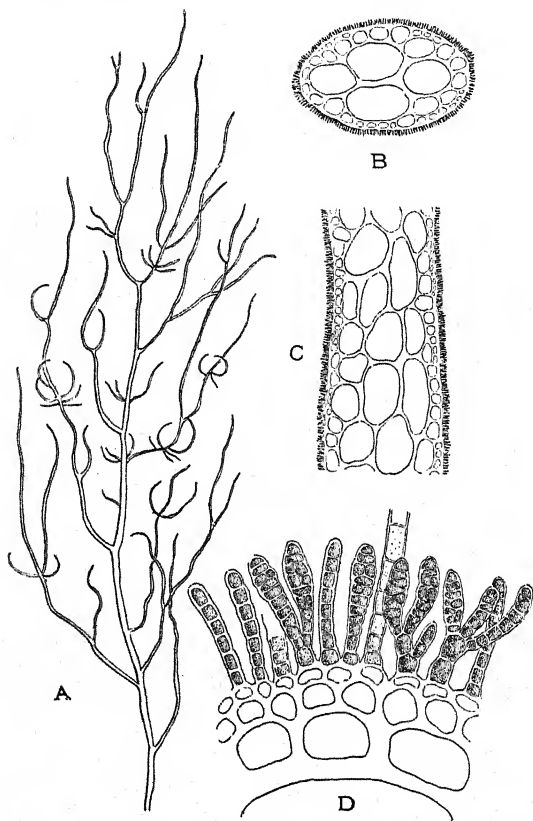


Fig. 89.—*Buffhamia speciosa* Batt. A. Epiphytic on *Castagnea Griffithsiana* (short filaments singly or in groups) ($\times 2$); B. Trans. sect. ($\times 30$); C. Long. sect. ($\times 30$); D. pluriloc. sporangia ($\times 300$).

B. speciosa Batt.—Fronds olive-brown, from 0.6–3 cm. in length and about 1 mm. in diam., filiform, tapering to both base and apex, solid. Epiphytic on the fronds of *Castagnea Griffithsiana* near low-water mark. Very rare; Dorset.

2. **CHORDARIA** C. A. Agardh

(Lat. *chorda*, a cord.)

Fronds cartilaginous, filiform, branching; axial layer of closely packed longitudinally elongated cells; peripheral layer

of short horizontal filaments. Uniloc. sporangia oblong, borne at the base of the peripheral filaments; pluriloc. sporangia unknown.

Key.

Ramuli very few, or none *C. flagelliformis*.
 Plant beset with short ramuli *C. divaricata*.

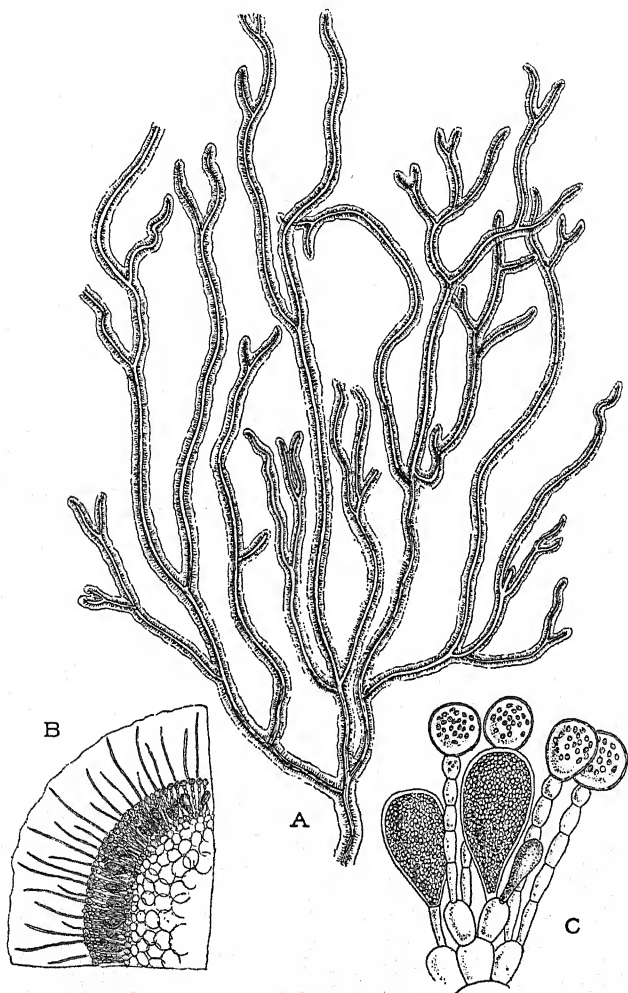


Fig. 90.—*Chordaria divaricata* C. A. Agardh. A. ($\times \frac{2}{3}$); B. Portion of trans. sect. ($\times 60$); C. uniloc. sporangia ($\times 300$).

C. divaricata C. A. Agardh. Lat. *divaricatus*, spread asunder.—Fronds tufted, 15–70 cm. long, olive-coloured, branching irregular; branches flexuose, clothed with short divaricate ramuli; axes at first solid, later becoming tubular; peripheral filaments short, the last cell obovoid and larger than the others; surface of the frond slimy, clothed with long byssoid gelatinous hairs. Uniloc. sporang. ovoid. Annual.

Very local; widely distributed.

C. flagelliformis C. A. Agardh. Lat. *flagellum*, a whip, *forma*, shape.—Fronds solitary or gregarious, 15–70 cm. long, filiform, very dark brown, solid, main axis usually undivided, with numerous long, subequal, flagelliform branches, given off at wide angles, simple, or with few secondary branches; peripheral filaments few-celled, cylindrical or slightly club-shaped; surface clothed with gelatinous hairs; substance cartilaginous with a slimy coat. Uniloc. sporang. ovoid or pyriform, borne at the base of the peripheral filaments. Annual.

On rocks and stones in the sea between tide-marks. Common.

var. **firmus** Kjellm.—Smaller than the type, thicker, more solid and rigid. Skerries, Co. Dublin.

var. **minor** J. G. Agardh.—Filiform, ramuli sub-pinnate. Northumberland and Edinburgh.

3. CASTAGNEA Derb. & Sol.

(After L. Castagne, French botanist.)

Fronds and uniloc. sporang. as in *Mesogloia*; pluriloc. sporangia developed from the upper articulations of the peripheral filaments.

Key.

- | | |
|-----------------------------------------------------------------------------------|--------------------------|
| 1. Peripheral filaments slender and curved | 2. |
| Peripheral filaments stout, erect and densely packed | <i>C. Zosteræ</i> (2). |
| 2. Frond alternately branched, with numerous ramuli | <i>C. virescens</i> (1). |
| Frond simple or dichotomously branched, ramuli absent or sparsely developed | <i>C. contorta</i> (3). |

1. **C. virescens** Thur. (*Mesogloia virescens* Carm.). Lat. *virescens*, turning green.—Fronds filiform, gelatinous, 7.5–50 cm. long, axis clothed with numerous irregular flexuose branches and small secondary branches, given off at wide angles; fronds at first solid, later becoming fistulous; peripheral filaments slender, dichotomously branched, clustered, recurved or incurved, cylindrical or only slightly moniliform. Uniloc. sporang. ovoid or rhombic-ovoid; pluriloc. sporang. siliculose, composed of 3–6 cells, formed from the terminal cells of the peripheral filaments, often secund on the upper side.

On sand-covered rocks and stones in puddles from half-tide level to low-water mark. Not uncommon on the S.E. and W.

Coasts of the British Isles, common and abundant in the Channel Islands.

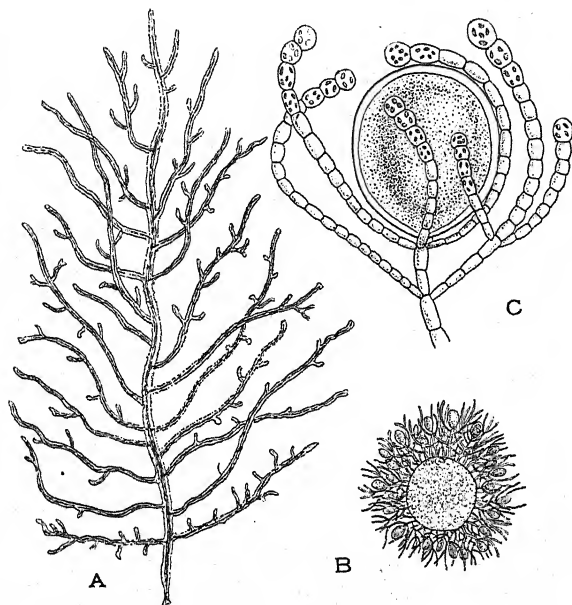


Fig. 91.—*Castagnea virescens* Thur. A. ($\times \frac{3}{8}$); B. Trans. sect. ($\times 16$); C. uniloc. sporangia ($\times 230$).

2. *C. Zosteræ* Thur. (*M. virescens* Carm., var. *zostericola* Harv.).—Fronds filiform, gelatinous, 7.5–20 cm. long, sub-simple, with a few short remote branches, given off at wide angles; peripheral filaments erect, rather rigid, cylindrical below, moniliform above, cells spheroidal. Uniloc. sporang. ovoid; pluriloc. sporang. siliculose, composed of 3–6 cells, usually forming dense tufts on the upper part of the peripheral filaments.

On *Zostera*. Probably common.

3. *C. contorta* Thur.—Fronds yellowish brown, gelatinous, 2.5–7.5 cm. long, simple or dichotomously branched, incurved, attenuate at the base and apex, bearing very small ramuli at certain seasons. Pluriloc. sporang. borne in clusters at the apices of branched peripheral filaments.

On dead leaves and rhizomes of *Zostera*. Rare; South Coast and Ayr.

4. *MESOGLOIA* C. A. Agardh

(Gr. *mesos*, in the middle, and *gloios*, slimy.)

Fronds olive-brown, gelatinous, filiform, branching; axial layer composed of filaments rather loosely united into a solid

mass, which soon becomes fistulose; peripheral layer of short horizontal filaments, packed in a gelatinous substance. Uniloc. sporangia ovoid, borne at the base of peripheral filaments; pluriloc. sporangia unknown, except in *M. Leveillei*, where they are stalked, elongated, or somewhat egg-shaped, borne on the peripheral filaments.

Key.

1. Frond slender, equal throughout 3.
Frond thick, unequally distended 2.
2. Texture cartilaginous *M. Leveillei* (2).
Texture gelatinous..... *M. vermiculata* (1).
3. Plant 30-50 cms. long, clothed with numerous
colourless hairs *M. Griffithsiana* (4).
Hairs absent, plant 5-12.5 cm. long *M. lanosa* (3).

1. ***M. vermiculata*** Le Jol. (*M. vermicularis* C. A. Agardh).
Lat. *vermiculatus*, worm shaped.—Fronds tufted, gelatinous,

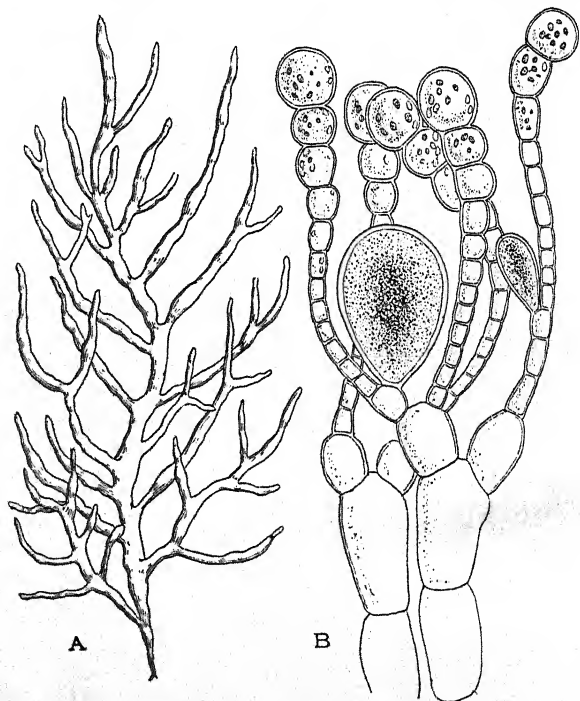


Fig. 92.—*Mesogloia vermiculata* Le Jol. A. ($\times \frac{3}{4}$); B. uniloc. sporangia ($\times 300$).

2.5-5 cm. long, muddy olive, yellowish or brown; branches long, irregularly pinnate, thick, vermiform, flexuose; peripheral

filaments clavate, somewhat incurved, moniliform, cells spheroidal. Uniloc. sporang. ovoid. Annual.

On rocks and stones in the sea, about half-tide level. Widely distributed; abundant in some localities, especially N.E. Scotland; less plentiful in the south.

2. *M. Leveillei* Menegh. (*Liebmannia Leveillei* J. G. Agardh, *L. major* Crouan). After J. H. Leveillé, French cryptogamist.—Resembling *M. vermiculata* in habit and structure but with thicker and firmer tissue. Uniloc. sporang. club-shaped or oval; pluriloc. sporang. borne on short or long stalks, simple or digitate, variable in size, borne laterally on the peripheral filaments.

Rare; Elgin and Channel Islands.

3. *M. lanosa* Crouan. Lat. *lanosus*, woolly.—Fronds gelatinous, 6–12.5 cm. long, branched from the base; branches incurved, alternate, clothed with short ramuli; peripheral filaments simple, articulations moniliform, about equal in length and breadth. Sporang. spherical or ovoid, borne at the base of the peripheral filaments.

On rocks and algæ at low-water mark. Probably not uncommon; Dorset and Bute.

4. *M. Griffithsiana* Grev. After Amelia W. Griffiths, British algologist.—Thallus 10–20 cm. long, gelatinous, flaccid and slippery, olive-green, branched, membranous, sometimes tubular when old; centre of young thallus composed of elongated cells parallel to the axis, the periphery of thin, short, vertical filaments 60–120 μ long; simple or dichotomously branched, club-shaped, interspersed with fine hairs. Unilocular sporang. stalked.

In rock pools between tide-marks. Locally abundant; widely distributed.

Family VI.—MYRIONEMACEÆ

Plants minute, forming spots or thin expansions on other algæ, consisting of prostrate filaments united into a horizontal membrane, from which short vertical filaments arise, between which the sporangia are borne. Uniloc. and pluriloc. sporangia as in *Ectocarpus*.

1. *MYRIONEMA* Grev.

(Gr. *myrios*, numberless, and *nema*, a thread.)

Olive-brown, forming thin expansions on other algæ, composed of a horizontal layer of cells lying on the substratum, from which numerous, closely packed, vertical filaments arise. Uniloc. and pluriloc. sporang. formed between the vertical filaments, either sessile on the horizontal layer or on short pedicels; hairs arising from the horizontal layer; growth peripheral.

Key.

1. Parasitic on *Laminaria saccharina* *M. æcidioides* (5).
Epiphytic on other algæ or saxicolous 2.
2. On stones *M. saxicolum* (6).
On other algæ 3.
3. Erect and procumbent filaments bearing small
protuberances *M. papillosum* (3).
Without protuberance 4.
4. Forming gelatinous spots on or near the receptacles
of *Fucus serratus* *M. polycladum* (4).
Not on *F. serratus* 5.
5. Cross walls of erect filaments transverse, pluriloc.
sporang. unknown *M. strangulans* (1).
Cross walls of erect filaments oblique, pluriloc.
sporang. abundant, cylindrical or slightly
torulose *M. coronæ* (2).

1. *M. strangulans* Grev.—Occurring in confluent, brown, convex patches on *Ulva* spp. or completely investing the cylindrical fronds of *Enteromorpha* spp. or on other algæ; vertical filaments clavate, densely set; articulations $1\frac{1}{2}$ times as long as broad. Uniloc. sporang. oval, sessile or borne on short pedicels.

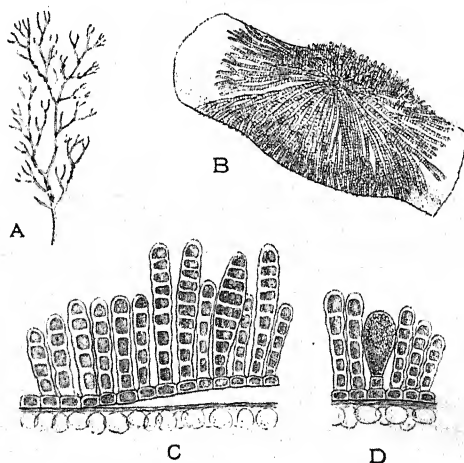


Fig. 93.—*Myrionema strangulans* Grev. A. Colonies on host ($\times \frac{2}{3}$); B. ($\times 60$); C. pluriloc. sporangia ($\times 300$); D. uniloc. sporangium ($\times 300$).

Epiphytic on *Ulva*, *Enteromorpha*, and other algæ.
Common.

var. *punctiforme* Holm. & Batt. (*M. punctiforme* Harv., *M. intermedium* Foslie).—Patches globose, spores borne on vertical filaments near the base. Not uncommon; widely distributed.

2. **M. Corunnæ** Sauv. La Coruña, Spain.—Distinguished from *M. strangulans* Grev. by the usually very abundant cylindrical or slightly torulose pluriloc. sporang., and the often oblique cross walls of the erect filaments with occasional longitudinal divisions. Sporang. sessile on the basal layer or borne on a 1-4 celled pedicel, usually simple, occasionally branched.

On *Laminaria*. Not uncommon; widely distributed.

3. **M. papillosum** Sauv.—Disc formed of radial filaments, erect filaments 120-220 μ long, bearing numerous small protuberances; articulations 1-4 times longer than broad, hairs frequent. Uniloc. sporang. sessile or shortly stalked, arising from the basal disc or formed laterally on the erect filaments; pluriloc. sporang. either on the basal disc or terminal or lateral on the erect filaments.

On *Laminaria saccharina*. Not uncommon; Dorset.

4. **M. polycladum** Sauv. Gr. *polus*, many, *klados*, a branch.—Erect filaments, cylindrical, simple or branched, arising from each cell of the basal disc, some hairs being present with basal growth and a slender collarette, at the base of the meristematic regions; articulations 1½ to twice as long as broad, terminal cell often swollen. Pluriloc. sporang. stalked, borne laterally or terminally on the erect filaments.

Forming gelatinous spots on the receptacles or neighbouring parts of the thallus of *Fucus serratus*. Probably not uncommon; Dorset.

5. **M. aecidioides** Sauv. (*Ectocarpus aecidioides* Rosenv.). *Aecidium*, an old genus of fungi, Gr. *eidos*, like.—Basal portion consisting of simple or branched endophytic filaments, penetrating the cells of the host; erect filaments simple or rarely branched, cells cylindrical, articulations 1½ to 3 times as long as broad. Uniloc. sporang. in sori, accompanied by hyaline hairs, sporang. obovate, often obliquely attenuating; pluriloc. sporang. elongated, 5-7 times as long as broad, accompanied by numerous hairs.

Parasitic on the leafy portions of *Laminaria saccharina*. Not uncommon.

6. **M. saxicolum** Kuck. Lat. *saxum*, a stone, *colo*, I inhabit.—Forming small tufts on stones; basal layer one or two cells thick, bearing erect filaments and hyaline hairs with basal growth; articulations of assimilating filaments about equal in length and breadth. Uniloc. sporang. 40-45 μ by 18-28 μ , sessile, borne on the basal layer.

Rare; Swanage.

2. STREPSITHALIA Sauv.

(Gr. *strepsis*, a twisting, and *thalos*, a shoot.)

Thallus endophytic, monosiphonous, gelatinous, primary filaments penetrating the host, assimilating filaments erect,

clavate. Uniloc. and pluriloc. sporangia homologous with assimilating filaments. Differing from *Elachistea* by the non-cohesion of the procumbent filaments into a pseudoparenchymatous tissue, and by the more gelatinous thallus.

S. Buffhamiana Batt. (*Streblonema Buffhamiana* Batt.). After T. H. Buffham, British algologist.—Primary filaments decumbent, creeping between the cortical filaments of the host,

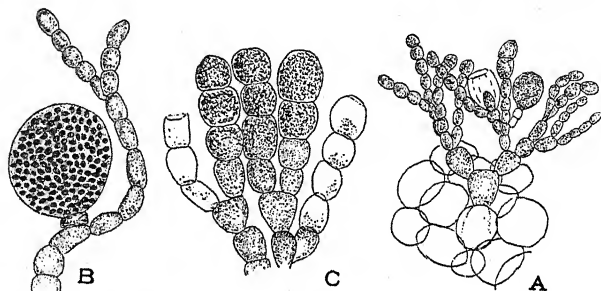


Fig. 94.—*Strepsithalia Buffhamiana* Batt. In cortical filaments of *Mesogloia*. A. Assimilating filaments and uniloc. sporangia ($\times 70$); B. Single uniloc. sporangium ($\times 280$); C. Pluriloc. sporangia (?) ($\times 280$).

much and irregularly branched, slightly nodose; secondary filaments springing from the procumbent filaments, clavate, all of nearly the same length, forming a tuft. Uniloc. sporang. ovoid or roundish, sessile or nearly so, borne at the base of the erect filaments.

In the cortical layers of *Mesogloia Griffithsiana* and *M. vermiculata*. Cornwall and Dorset.

3. **RALFSIA** Berk.

(After J. Ralfs, British algologist.)

Fronds olive-brown, forming flat expansions of indefinite extent, composed of a single horizontal layer, from which short vertical filaments arise firmly united together to form a parenchymatous structure; fructifications in sori, composed of club-shaped many-celled paraphyses, at the base of which the uniloc. sporang. are borne.

Subgenus 1.—**Stragularia** Strömf., emend Foslie

Fronds composed of a single horizontal layer, from which arise short vertical filaments loosely united together.

Key.

Clusters of hairs borne at intervals, giving plant a punctate appearance	<i>R. pusilla</i> .
Clusters of hairs absent	<i>R. disciformis</i> .

R. pusilla Batt. (*Stragularia pusilla* Strömf.). Lat. *pusillus*, very small.—Forming small patches, light olive-brown to nearly black; erect filaments vertical, arising from a single horizontal layer; clusters of hairs borne at intervals, giving the thallus a punctate appearance; articulations equal in length and breadth. Sporang. and paraphyses clavate.

On *Zostera*, *Chaetomorpha*, *Laminaria saccharina* and other algæ. Very rare; widely distributed.

R. disciformis Crouan.—Forming a yellowish brown disc, 1–3 cm. in diam., adhering closely to the substratum, thick in the centre, thinner near the edges, margin entire or lobed; articulations 2–3 times as long as broad near the base. Sporang. clavate, numerous, occupying the centre of the frond, accompanied by paraphyses.

Very rare. Dredged from deep water, Plymouth Sound.

Distinguished from *R. clavata* by the shorter, less clavate paraphyses, often composed of only one or two cells, scarcely longer than the sporang.

Subgenus 2.—**Euralfsia** Batt.

Short vertical or slightly curved filaments united into a parenchymatous structure.

Key.

1. Paraphyses clavate 2.
 Paraphyses cylindrical or slightly attenuate at
 the apex *R. spongiocarpa* (2).
2. Forming large coriaceous expansions, producing
 uniloc. sporang. abundantly during winter ... *R. verrucosa* (1).
 At first orbicular, later indefinite in outline, central
 part often dying away in winter *R. clavata* (3).

1. **R. verrucosa** Aresch.—Forming coriaceous expansions, often of considerable size. Uniloc. sporang. abundant during winter, accompanied by clavate paraphyses; pluriloc. sporang. rare, not accompanied by paraphyses, formed from the vertical filaments of the thallus, closely packed together.

On rocks in pools from high-water mark to half-tide level. Common.

2. **R. spongiocarpa** Batt. (*R. clavata* Reinke, non Farlow). Gr. *spongos*, sponge, *karpon*, fruit.—Paraphyses cylindrical or slightly attenuate at the apex, never club-shaped, composed of 10–12 cells; slightly broader than long below. Sporang. oval, sometimes nearly globular, usually lateral at the base of the paraphyses, but occasionally terminal; pluriloc. sporang. (?) forming indefinite sori on the surface of the frond.

On the rocky bottoms of shallow pools half filled with sand, near low-water mark. Rare; widely distributed.

3. *R. clavata* Farlow (*Myrionema clavatum* Harv., *Ralfsia clavata* Crouan, *R. Borneti* Kuck., and *Stragularia adherens* Strömf.).—At first orbicular, soon becoming indefinite in outline, central part often dying away in winter. Uniloc. sporang. large, pyriform; club-shaped paraphyses composed of 6-7 cells much

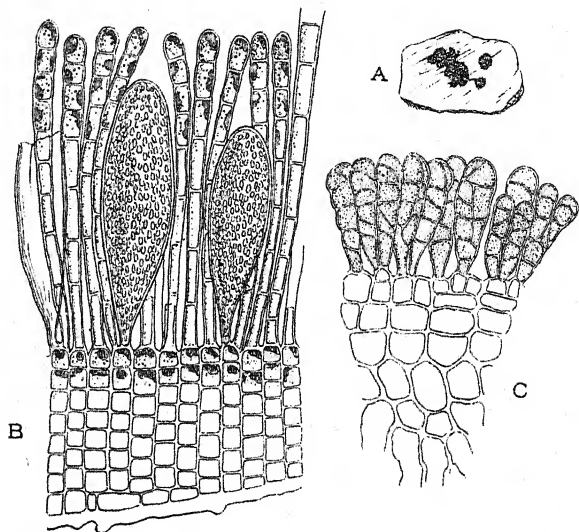


Fig. 95.—*Ralfsia clavata* Farlow. A. ($\times \frac{2}{3}$); B. showing uniloc. sporangia ($\times 300$); C. pluriloc. sporangia ($\times 300$).

longer than broad below, about equal in length and breadth above; either a single paraphysis, or two together, or a paraphysis and a sporangium arising from a single cell of the vertical filaments which compose the thallus. Pluriloc. sporang. formed from the vertical filaments, not accompanied by paraphyses.

On rocks and stones from half-tide level to low-water mark. Locally abundant; widely distributed.

4. *ULONEMA* Foslíe

(Gr. *oulos*, shaggy, and *nema*, a thread.)

Thallus epiphytic, erect filaments numerous, attachment rhizoids developed from the pseudoparenchymatous basal tissue. Uniloc. sporangia arising from the procumbent parts or borne on the erect filaments; pluriloc. sporangia elongated, probably borne on the basal layer.

U. rhizophorum Foslíe. Gr. *rhiza*, a root, *phoreo*, I carry.—Forming small flattened hemispherical expansions, 1-3 mm.

in diam., often surrounding the thallus of the host ; procumbent filaments densely crowded, forming a pseudoparenchymatous disc, except near the edge from which numerous rhizoids penetrate slightly between the host tissue ; erect filaments numerous, usually simple, densely crowded, longest in the centre of the

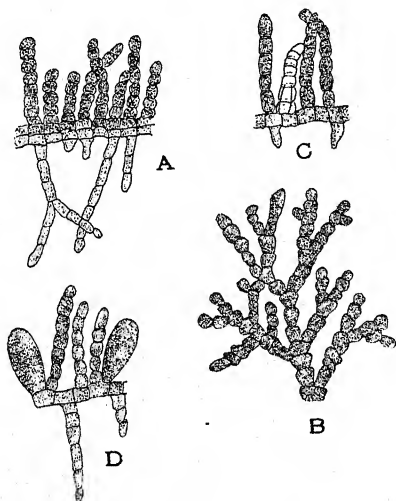


Fig. 96.—*Ulonema rhizophorum* Foslie. A. Trans. sect. showing erect filaments and rhizoids ; B. edge of growing colony ; C. pluriloc. sporangia ; D. uniloc. sporangia ($\times 200$).

colony ; articulations $1-2\frac{1}{2}$ times as long as broad ; hairs few, about 10μ thick. Uniloc. sporang. obovoid, roundish, or sub-clavate, arising from the procumbent filaments, or the basal cell of the erect filaments.

On *Dumontia filiformis*. Not uncommon ; widely distributed.

5. HECATONEMA Sauv.

(Gr. *hekatón*, a hundred, and *nema*, a thread.)

Consisting of a basal disc and erect filaments of unequal length, produced abundantly in the centre of the disc, sparsely distributed near its edges. Otherwise similar to *Myrionema* Grev.

Key.

- | | |
|------------------------------------------------------------------------------------|-------------------------|
| 1. Hairs present | 2. |
| Hairs absent | 4. |
| 2. Articulations of assimilating filaments about equal in length and breadth | 3. |
| Articulations of assimilating filaments twice as long as broad | <i>H. globosum</i> (2). |

3. Erect filaments often terminating in a hair, sporang.
borne on basal disc or shortly stalked *H. maculans* (1).
Hairs and sporang. borne directly from the basal
layer *H. speciosum* (4).
4. Basal disc usually 2 cells thick, articulations of
erect filaments about as long as broad *H. reptans* (3).
Basal disc usually 1 cell thick, articulations of erect
filaments 2-6 times as long as broad *H. Liechtensternii* (5).

1. *H. maculans* Sauv. Lat. *maculans*, spotted.—Forming a disc, 2 mm. or more in diam., often mingled with *Myrionema vulgare*, from which it is distinguished by its larger basal cells. Hairs erect, filaments simple or branched; articulations about as long as broad, assimilating filaments often terminating in a hair. Pluriloc. sporang. ovoid, sessile or shortly stalked, borne on the basal disc or on the erect filaments.

On *Rhodymenia palmata* and *Ulva lactuca*. Rare; Devon and Dorset.

2. *H. globosum* Batt. (*Ascocyclus globosus* Reinke).—Arising from a basal disc, irregular when young, later almost circular, separating easily into fan-shaped segments; hairs arising from the basal cells; erect filaments branched or unbranched; articulations twice as long as broad. Sporang. sessile or stalked.

Epiphytic on *Rhodymenia palmata*, *Chaetomorpha* and *Cladophora*. Very rare; Cumbræ.

Form varying with the host.

3. *H. reptans* Sauv. (*Ascocyclus reptans* Reinke). Lat. *reptans*, creeping.—Primary filaments horizontally expanded, united into a disc or irregular expansion, usually composed of 2 layers of cells from which arise short simple erect filaments and shortly pedicellate

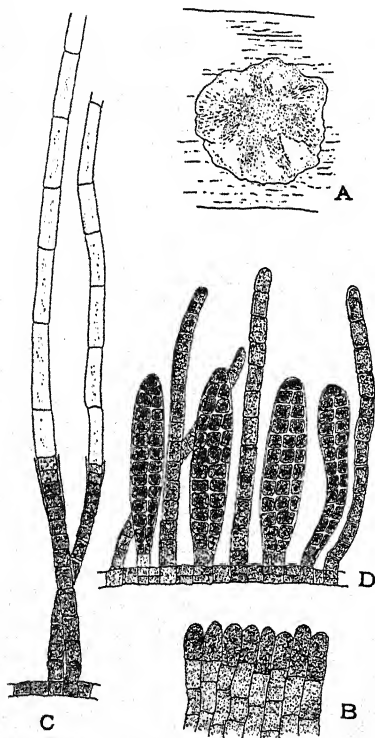


Fig. 97.—*Hecatonema maculans* Sauv.
A. Colony ($\times 8$); B. edge of colony
($\times 200$); C. hairs ($\times 200$); D.
Section of thallus with pluriloc.
sporangia ($\times 200$).

sporangia; articulations of the upright filaments about as long as broad, those of the decumbent filaments a little longer.

On *Chondrus*, *Halidrys* and *Cladophora*, between tide-marks. Rare; widely distributed.

4. **H. speciosum** Cotton (*Myrionema speciosum* Börg., *Hecatonema diffusum* Kylin). Lat. *speciosus*, handsome.—Basal layer one cell thick with marginal growth, pseudoparenchymatous in the centre, filamentous near the edge; erect assimilating filaments 100–250 μ in length; articulations once or twice as long as broad; hairs numerous, with diam. equal to that of the assimilating filaments, usually formed directly from the basal layer. Pluriloc. sporang. sessile or stalked, arising from the basal layer.

Forming confluent patches on *Fucus vesiculosus*, *Laminaria digitata* and other algæ. Common, especially in Spring.

5. **H. Liechtensternii** Batt. (*Myrionema Liechtensternii* Hauck). After F. Liechtenstern, Austrian collector.—Forming roundish olive-brown patches, about 5 mm. in diam. on coral-lines; filaments of the basal layer irregularly branched; erect filaments simple or branched; articulations 2–6 times longer than their breadth. Pluriloc. sporang. borne terminally or laterally on the erect filaments, filamentous, bearing one row of spores.

Very rare; Berwick.

6. CHILIONEMA Sauv.

(Gr. *chiloi*, a thousand, and *nema*, a thread.)

Consisting of a basal disc with peripheral growth, similar to those of *Myrionema* and *Hecatonema*; erect filaments, among which the sporangia are borne, occurring in irregular dense patches, separated by sterile or almost sterile areas.

Key.

- | | |
|------------------------------------------------------------------------------------------------------|--------------------------|
| 1. Erect filaments in irregular patches | 2. |
| Erect filaments in concentric bands | <i>C. ocellatum</i> (3). |
| 2. Thallus 1–2 mm. in diam., erect filaments in large or small groups | <i>C. reptans</i> (1). |
| Thallus 1 cm. or less in diam., erect filaments in patches, densest in the centre of the thallus ... | <i>C. Nathalieæ</i> (2). |

1. **C. reptans** Sauv. Lat. *reptans*, creeping.—Thallus 1–2 mm. in diam., basal layer often 2 cells thick; erect filaments irregularly arranged in large or small groups, assimilating filaments sometimes terminating in a hyaline hair; articulations about equal in length and breadth in the erect filaments, rather longer than broad in the procumbent parts. Sporang. sessile or shortly stalked arising from the basal layer.

Very rare; widely distributed.

2. **C. Nathalieæ** Sauv. (*Myrionema Leclancherii* Harv. pro parte). After Nathalie Karsakoff, French collector.—Thallus

1 cm. or less in diam., orbicular or slightly irregular, composed at first of decumbent filaments radiating from a centre, closely cohering together; erect filaments developed in patches, the most dense occupying the centre of the thallus; articulations about equal in length and breadth in the erect filaments, rather longer than broad in the procumbent parts. Uniloc. and pluriloc. sporang. shortly pedicellate, arising from the basal layer.

Rare; Devon and Dorset.

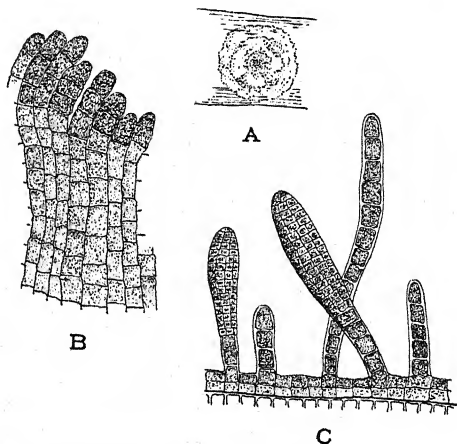


Fig. 98.—*Chilionema reptans* Sauv. A. Colony ($\times 8$); B. edge of colony ($\times 270$); C. Section of host and epiphyte showing pluriloc. sporangia ($\times 270$).

3. *C. ocellatum* Sauv. (*Ascocyclus ocellatus* Reinke). Lat. *ocellatus*, with a little eye.—Thallus minute, composed of a basal plate bearing erect filaments with zonate distribution, the centre portion and alternate pericentral bands 2 cells thick bearing erect filaments and sporangia, the intermediate zones and extreme margin, 1 cell thick and sterile.

Rare; widely distributed.

7. *ASCOCYCLUS* Magn.

(Gr. *askos*, wine skin, and *kuklos*, a circle.)

Differs from *Myrionema* in having non-pigmented elongated cells, (*ascocysts*), arising from the basal layer, sessile or shortly stalked.

Key.

- | | |
|-----------------------------------------------|----------------------------|
| 1. Without erect assimilating filaments | <i>A. orbicularis</i> (1). |
| With erect assimilating filaments | 2. |
| 2. Hairs rarely present | <i>A. hispanicus</i> (2). |
| Hairs abundant | <i>A. fecundus</i> (3). |

1. *A. orbicularis* Magn.—Consisting of a basal layer one cell thick, and no erect assimilating filaments; articulated colourless hairs developed, together with numerous ascocysts. Uniloc. sporang. unknown; pluriloc. sporang. shortly stalked, springing from the basal layer.

On the leaves of *Zostera*. Not uncommon; widely distributed.

2. *A. hispanicus* Sauv. Lat. *hispanicus*, Spanish.—Forming dark blackish brown irregular tufts, up to 2 cm. in diam.; procumbent basal portion adhering firmly to the substratum, forming a pseudoparenchymatous tissue, erect filaments simple or very occasionally branched; ascocysts cylindrical, elongated; hairs very rare, usually absent. Uniloc. sporang. pyriform (?); pluriloc. sporang. elongated, terminal on the erect filaments.

On *Saccorhiza bulbosa*, *Fucus serratus* and *Himanthalia lorea*. Rare; Devon and Dorset.

3. *A. fœcundus* Cotton (*Phycocelis fœcunda* Strömf., *A. sphaerophorus* Sauv., *A. islandicus* Jons., *A. saccharinæ* Cotton, *A. affinis* Cotton, non Sved.). Lat. *fœcundus*, fertile.—Forming tufts as much as 6 mm. in diam., isolated or confluent; erect filaments simple, interspersed with hairs developed at an early stage, and stalked or sessile ascocysts, clavate or cylindrical, formed from the basal layer. Uniloc. sporang. unknown; pluriloc. sporang. elongated, sessile or stalked, borne on the basal layer.

On *Rhododymenia palmata* in the littoral region, and on *Laminaria saccharina*. Locally abundant; S. England, Channel Islands and Clare Island.

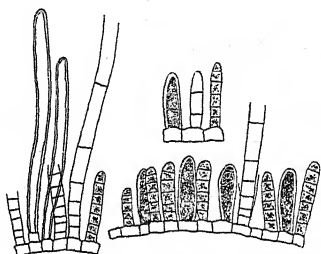


Fig. 99.—*Ascocyclus orbicularis* Magn.

Portions of colony with ascocysts, articulated hairs and pluriloc. sporang. ($\times 200$).

Family VII.—SPERMATOCHEACEÆ

Thallus much branched with a distinct central axis of elongated cells bounded by a cortical layer of smaller irregular assimilating cells, from which more or less elongated filaments and hairs arise, particularly in the younger parts. Sporangia borne at the base of more or less clavate paraphyses or intercalary.

1. MYRIOCLADIA J. G. Agardh

(Gr. *myrios*, innumerable, and *klados*, a branch.)

Main axis cylindrical, branched, hollow in the centre, formed of a parenchymatous tissue from which radiating assimilating

filaments arise peripherally, bearing numerous branchlets, often moniliform. Uniloc. sporang. obovoid, sessile or shortly stalked, in the axils of the assimilating filaments; pluriloc. sporang. elongated, intercalary in the branchlets of the peripheral filaments.

Key.

Peripheral assimilating filaments simple *M. tomentosa*.
Peripheral assimilating filaments branched *M. Loveni*.

M. Loveni J. G. Agardh. After N. H. Lovén, Swedish zoologist.—Frond tubular, flaccid, gelatinous, muddy olive, sparsely branched; peripheral assimilating filaments numerous; articulations cylindrical, elongated, ellipsoidal near the base, moniliform above. Uniloc. sporang. shortly stalked, borne on the assimilating filaments.

Very rare; Sussex.

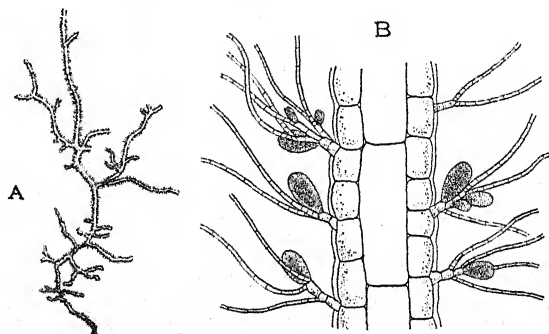


Fig. 100.—*Myriocladia Loveni* J. G. Agardh. A. ($\times \frac{2}{3}$); B. Section showing uniloc. sporangia ($\times 170$).

M. tomentosa Crouan. Lat. *tomentosus*, woolly.—10–20 cm. long, tomentose, sparsely branched, branches short, almost simple; peripheral assimilating filaments elongated, simple, usually recurved, attenuate at the apex; articulations 2–3 times as long as broad. Uniloc. sporang. spherical or ovoid, sessile on the assimilating filaments.

In deep water. Very rare; Weymouth.

2. SPERMATOCHEMUS Reinke

(Gr. *sperma*, a seed, and *chnoos*, fine down.)

Fronds filiform, cylindrical, elongated, regularly branched, hairs present; central axis consisting of a central cell, and a band of corticating cells from which elongated assimilating

filaments and hairs arise. Uniloc. sporangia in sori, the sporangia arising from the base of clavate paraphyses.

Key.

Apices of the branches clothed with peripheral filaments	<i>S. paradoxus.</i>
Apices of the branches without peripheral filaments	<i>S. Lejolisii.</i>

S. paradoxus Kütz. (*Stilophora Lyngbyei* J. G. Agardh).
—Frond tubular in the older parts, much branched; branches dichotomous, spreading, with wide angles, attenuate at the apices; olive-brown, becoming greener in drying; substance

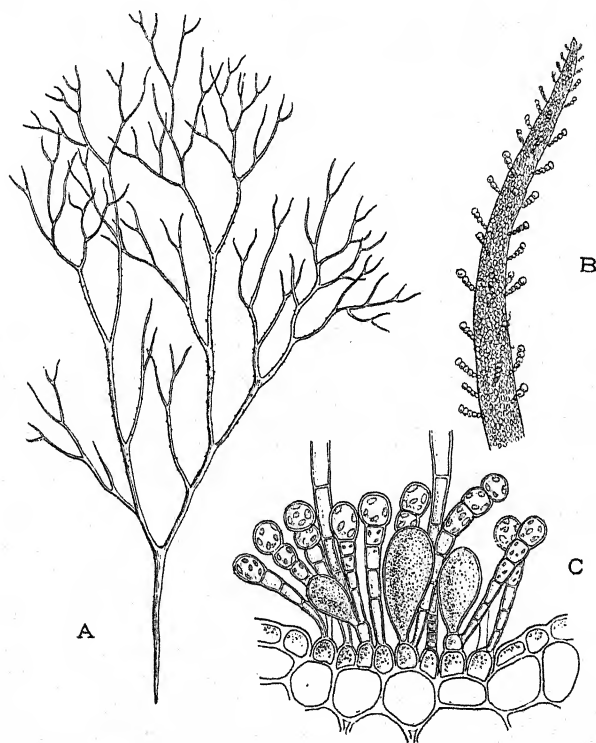


Fig. 101.—*Spermatochnus paradoxus* Kütz. A. ($\times \frac{2}{3}$); B. Axis showing assimilating filaments (after Reinke); C. uniloc. sporangia and paraphyses ($\times 300$).

crisp and brittle when fresh, adhering to paper. Sporang. borne on paraphyses in spherical sori, arranged in transverse, slightly spiral bands. Annual, Summer.

In land-locked bays and estuaries on a muddy and sandy bottom, in 4-10 fathoms. Rare; widely distributed.

S. Lejolisii Reinke (*Stilophora Lejolisii* Thur.). After A. Le Jolis, a French algologist.—Branching dichotomous, branches elongated, secondary branches few, apices attenuate, not clothed with peripheral filaments. Sori not sharply differentiated, sporang. being formed in an almost continuous layer.

On stones, among *Mesogloia Griffithsiana*, and *Cystoseira ericoides*. Rare; widely distributed.

3. **STILOPHORA** J. G. Agardh

(Gr. *stulos*, a point, and *phoreo*, I bear.)

Fronds filiform, branching, solid, becoming hollow with age, with central portion of elongated colourless cells, and small assimilating cells in the outer layers. Sori hemispherical, scattered over the surface, consisting of club-shaped paraphyses with the sporangia among them; uniloc. sporangia ovoidal; pluriloc. sporangia cylindrical, formed of a single row of cells.

Key.

Branching subdichotomous, ultimate divisions erect	<i>S. rhizodes</i> .
Branching dichotomous, branches spreading	<i>S. tuberculosa</i> .

S. rhizodes J. G. Agardh. Gr. *rhiza*, a root, *eidos*, like.—Fronds filiform, solid, becoming somewhat fistulose 15-65 cm. long; branching subdichotomous, without a distinct axis; branches attenuate at their apices, ultimate divisions erect. Sori numerous, scattered irregularly over the frond; paraphyses few-celled, clavate, somewhat incurved. Uniloc. sporang. ovoid; pluriloc. sporang. cylindrical on different individuals. Annual, Summer.

Near low-water mark on rocks or on other algæ, especially where fresh water enters the sea. Not uncommon in S. England and S.W. Scotland; common in E., S. and W. Ireland.

S. tuberculosa Reinke.—Young frond subcylindrical solid, later becoming fistulous, attenuate upwards and cæspitose, 10-30 cm. long; ramuli patent, branching dichotomous. Uniloc. and pluriloc. sporang. obovoid-clavate, in the same or different sori; sori confluent and slightly projecting.

Epiphytic on Fuci. Locally abundant; Dorset and Bute.

Family VIII.—DESMARESTIACEÆ

Plants much branched, 60-180 cm. long, branches bearing smaller ramuli which are bilateral in *Desmarestia* and whorled in *Arthrocladia*, clothed during spring and summer with fila-

mentous hairs. In *Arthrocladia* the sporangia are formed on the hairs, the uniloc. sporangia resembling those of *Ectocarpus*

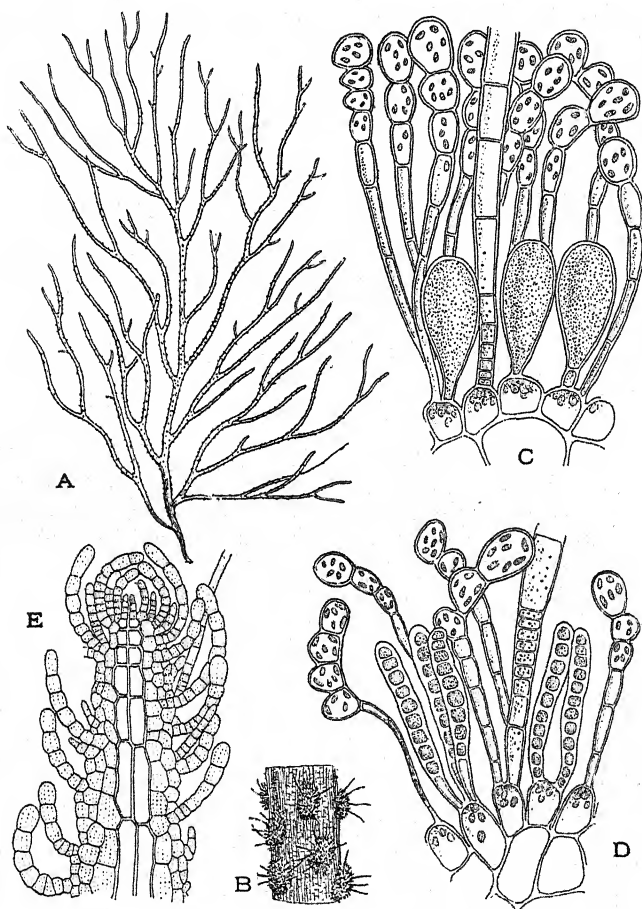


Fig. 102.—*Stilophora rhizodes* J. G. Agardh. A. ($\times \frac{3}{8}$); B. portion showing scattered sori (after Reinke); C. uniloc. sporangia and paraphyses ($\times 420$); D. pluriloc. sporangia ($\times 420$) E. (After Reinke.) Section of thallus near the apex.

or *Pilayella*. In *Desmarestia* the uniloc. sporangia are formed from the cortical cells. Fronds filiform or membranous, compressed, with indistinct midrib; attached by a basal disc.

1. **DESMARESTIA** Lamour.

(After A. G. Desmarest, French naturalist.)

Fronds filiform or compressed, sometimes with an obscure mid-rib; branches numerous, opposite or alternate, bearing fine filamentous hairs or short spine-like branchlets at various seasons. Uniloc. sporangia developed from the superficial cells of the cortical layer and containing a small number of zoospores, which escape from the sporangium in one mass. The genus is easily distinguished from most of its allies by its axial filament formed of a single row of cylindrical cells, and by the formation of the zoospores in unchanged superficial cells.

Key.

- | | |
|------------------------------------------------|---------------------------|
| 1. Frond cartilaginous | 2. |
| Frond membranous | 3. |
| 2. Branching opposite | <i>D. viridis</i> (1). |
| Branching alternate | <i>D. aculeata</i> (2). |
| 3. Much branched, ligulate. | <i>D. ligulata</i> (3). |
| Leafy thallus from 1.25-7.5 cm. in width | <i>D. Dudresnayi</i> (4). |

1. *D. viridis* Lamour. Lat. *viridis*, green.—Filiform, compressed or flat, much branched, 30 cm. or more in length, soft and flaccid, deep olive-brown when growing, quickly becoming green when removed from the water; branches repeatedly pinnate, the lower ones long, the upper gradually shorter; branches and branchlets more or less linear, clothed in summer with tufts of delicate green hairs; thallus consisting of a central cell surrounded by a wide band of large and small cortical cells. Uniloc. sporang. similar to those of *D. aculeata*. Spring and early summer.

On stones and larger algæ between tide-marks and below low-water mark. Not uncommon.

2. *D. aculeata* Lamour. Lat. *aculeatus*, somewhat prickled.—Slender, compressed, 30-180 cm. long, bright green and cartilaginous when young, becoming rigid, coarse, brown and spiny in the older stages, bearing numerous alternately pinnate branches, of which the ultimate pinnæ are short, giving the plant a serrate appearance in winter, clothed in summer with delicate branched filaments; transverse section showing one large central cell surrounded by a wide band of smaller cells, the plastids being confined principally to the outer parts. Uniloc. sporang. developed from the cortical cells, containing 15 or more zoospores. Perennial.

Common on rocks and stones in the sea, near low-water mark.

3. *D. ligulata* Lamour.—60-180 cm. long, with a short cylindrical cartilaginous stem soon becoming compressed, and passing into a flat linear undivided frond a few cms. from the base; primary frond with a more or less prominent midrib, closely and

repeatedly pinnate, with opposite distichous branches, bearing smaller pinnules, the latter being margined with minute spine-like teeth, which in young individuals produce tufts of delicate branching filamentous hairs, clear olive-brown and cartilaginous when fresh, soon becoming green and flaccid in the air; trans-

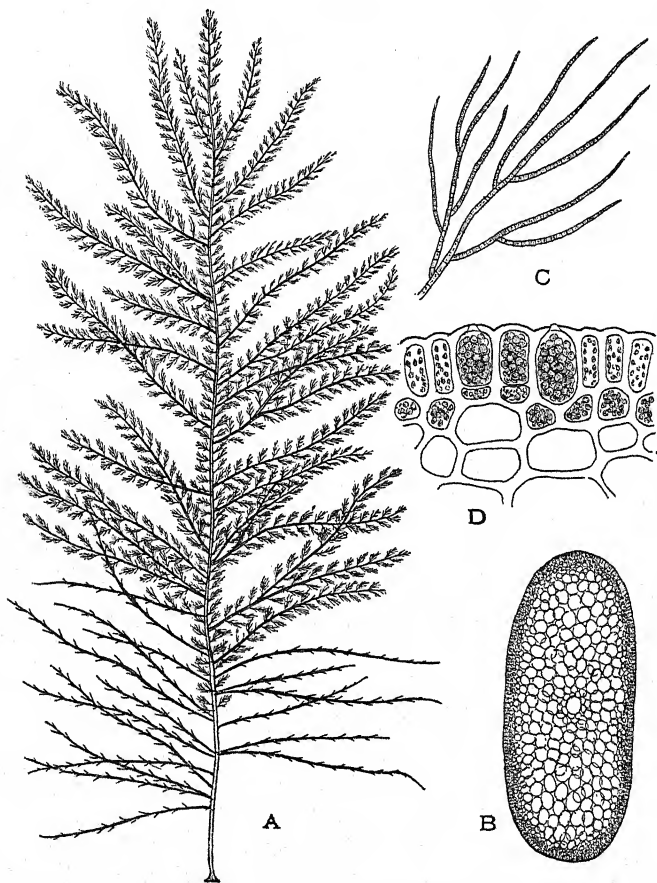


Fig. 103.—*Desmarestia aculeata* Lamour. A. ($\times \frac{3}{4}$); B. Section of thallus ($\times 130$); C. branching ($\times 33$); D. uniloc. sporangia ($\times 400$).

verse section showing single central cell and wide band of cortical cells arranged in three zones, the cells of the middle zone being larger than the rest. Sporang. similar to those of *D. aculeata*. Annual, Summer.

On the rocky bottom of submarine tide-pools, near low-water

mark and at greater depth. Not uncommon; S. and W. of England and Ireland, Channel and Orkney Islands.

var. *angustior* Batt.—Narrower than type, trebly pinnated, ramuli nearly entire. S. and W. England and Ireland and the Orkneys.

var. *dilatata* Batt.—Ramuli subelliptical, attenuate at their bases. S. England and Orkney Islands.

4. *D. Dudresnayi* Lamour.—After Col. Dudresnay, French collector.—Fond leathery, expanded laterally, pinnæ and pinnules opposite, elliptical, obtusely attenuate at the base.

Very rare; S. England, Ireland.

2. *ARTHROCLADIA* Duby

(Gr. *arthron*, a joint, and *klados*, a branch.)

Fronds filiform, much branched, consisting usually of a percurrent axis and widely spreading opposite branches bearing

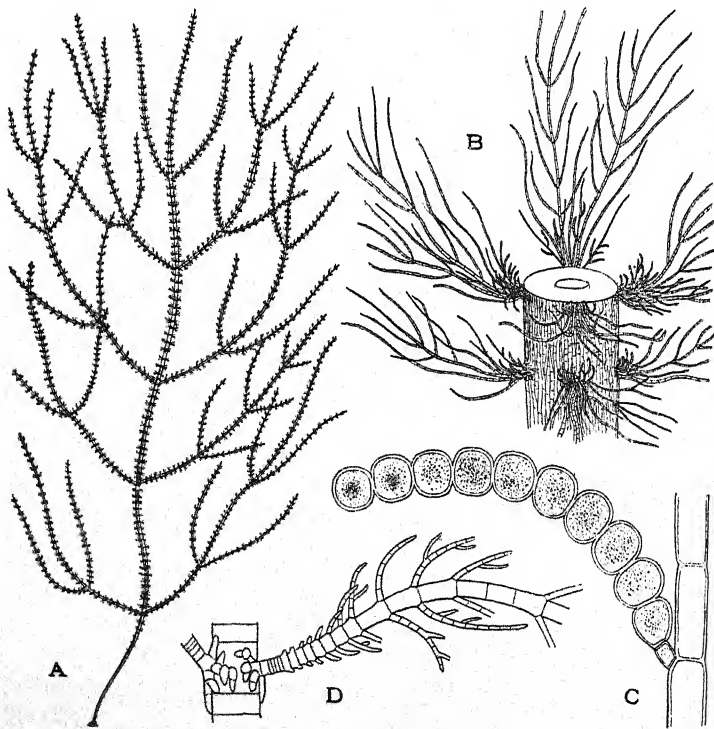


Fig. 104.—*Arthrocladia villosa* Duby. A. ($\times \frac{2}{3}$); B. ($\times 30$); C. uniloc. sporangia ($\times 420$); D. Young plants with attachment. (After Falkenberg.)

whorls of ramuli; thallus with a large central filament of cylindrical cells and a series of polygonal cortical cells becoming smaller towards the surface. Uniloc. sporangia moniliform, borne on branching monosiphonous filaments which form whorled tufts on the branches.

Arthrocladia may be distinguished from *Desmarestia* by its larger central filament and by the fact that the sporangia are borne in special stichidia.

A. villosa Duby. Lat. *villosus*, with shaggy hairs.—From 15–90 cm. long, delicately filiform with a percurrent axis and widely spreading opposite branches; cartilaginous when fresh, soon becoming flaccid, adhering to paper. Uniloc. sporang. borne in chains on monosiphonous filaments, arising laterally from the verticillate ramuli. Annual.

On submarine rocks, shells, and on *Zostera* in 4–8 fathoms. Rare; locally abundant; wide distribution.

Family IX.—DICTYOSIPHONACEÆ

Thallus filamentous, much branched, membranous, consisting in *Dictyosiphon* of two layers, an inner of large cells, bounded by an outer layer of small roundish or angular cells. In *Gobia* the outer layers consist of chains of assimilating cells perpendicular to the surface. Uniloc. sporangia oval or spherical, scattered or aggregated, formed from the sub-cortical layers.

1. DICTYOSIPHON Grev.

(Gr. *dictuon*, a net, and *siphon*, a tube.)

Thallus filamentous, much branched, lower part tubular, upper part solid, membranous. Uniloc. sporangia developed from a single sub-cortical cell, appearing sunk in the thallus when fully developed, oval or round. Sporang. germinate to form a microscopic protonema which gives rise to pluriloc. sporangia.

Key.

- | | |
|-----------------------------------------------------------------------------------|-----------------------------|
| 1. Filaments unbranched | <i>D. Elmani</i> (3). |
| Filaments branched | 2. |
| 2. Ramifications few, secondary branches absent ... | <i>D. Chordaria</i> (4). |
| Ramifications many | 3. |
| 3. Frond coarse, as much as 3 mm. broad, branches
arising at wide angles | <i>D. Mesogloia</i> (5). |
| Frond thin, branches clustered | 4. |
| 4. Branches long, flagellate, with few secondary
branches | <i>D. hippuroides</i> (2). |
| Branches long, repeatedly and irregularly divided ... | <i>D. fœniculaceus</i> (1). |

1. *D. fœniculaceus* Grev.—15–60 cm. long or more, usually with a main axis densely clothed with long lateral branches similar to the main axis, and bearing numerous lateral ramuli either elongated or short and curved, frequently bushy. Pale

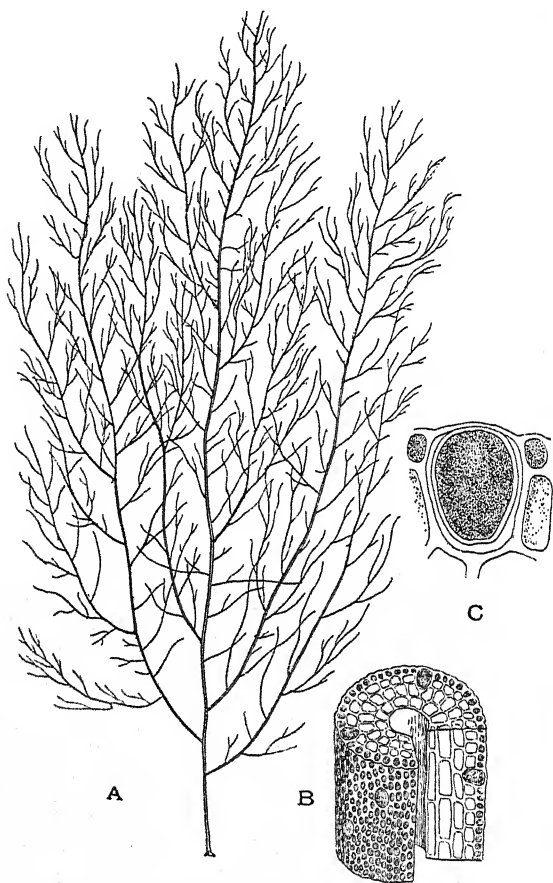


Fig. 105.—*Dictyosiphon fœniculaceus* Grev. A. ($\times \frac{2}{3}$); B. Portion ($\times 60$); C. uniloc. sporangium ($\times 300$).

olive-brown, densely clothed with pellucid jointed hairs when young, becoming darker with age, membranous and soft, adhering to paper; upper portion solid, with central large cells, older parts fistular; cortex of several layers, bounded by a limiting stratum of small, cubical or polygonal cells. Sporangia formed

in the cortex, ellipsoidal or roundish with longer axes parallel to the length of the frond. Annual, spring and summer.

On rock pools between tide-marks, on stones or epiphytic on *Chordaria flagelliformis*, *Scytosiphon lomentarius* and *Chorda Filum*. Not common; widely distributed.

var. *flaccida* Kjellm.—Smaller than the type, repeatedly branched, solid in the ultimate ramuli. Haddington, N. Berwick.

var. *hispidus* Kjellm.—Differs by smaller sporang. and peculiar branching. Rare.

Supposed by Gobi to be a richly branched form of *D. fœniculaceus* var. *flaccida*.

2. *D. hippuroides* Kütz. *Hippuris*, a genus of flowering plants, Gr. *eidōs*, like.—10–30 cm. long, upper parts solid, lower parts tubular, much branched, branches denser near the top, looser in consistency than *D. fœniculaceus* Grev.; thallus clothed with colourless hairs when young, dark olive-brown becoming almost black, membranous and soft, adhering to paper. Uniloc. sporang. borne in the thallus. Annual.

Epiphytic on other algæ, e.g. *Chordaria flagelliformis*, and on stones, chiefly littoral. Common; N. England and S. Scotland, probably not uncommon N. Scotland and Ireland.

var. *fragilis* Kjellm.—Looser consistency than the type, coarse branches increasing in thickness upwards. Rare Orkneys, Kilkee, Co. Clare.

3. *D. Ekmani* Aresch. After J. L. Ekman, Swedish algologist.—Filaments usually unbranched, bearing numerous hairs when young.

Epiphytic on *Scytosiphon lomentarius* and *Cystoclonium purpurascens* in pools near high-water mark. Rare; Cornwall, Dorset, Northumberland and Fife.

4. *D. Chordaria* Aresch. Dark olive, usually with a well-marked central axis and lax branching; ramifications of the main axis few, usually wholly unbranched and attaining a considerable length.

Rare; Northumberland and Scotland.

Somewhat resembling *Dumontia filiformis* Grev. in outward appearance.

5. *D. Mesogloia* Aresch. Gr. *mesos*, in the middle, *gloios*, sticky.—Fronds hollow below, irregularly branched, branches arising at wide angles and furnished with short ramuli attenuate at the base and apex.

In the littoral region, attached to stones. Very rare; Northumberland and Scotland.

Fronds much thicker than those of any other British species of *Dictyosiphon*. Resembling *Castagnea virescens* Thur. in outward appearance, distinguished from it by the acute apices of the ramuli and in being lubricous, not gelatinous.

2. **GOBIA** Reinke

(After K. Y. Ghobi, Russian algologist.)

Differs from *Dictyosiphon* Grev. in that the outer layer consists of short chains of gelatinous assimilating cells, arranged vertically to the surface.

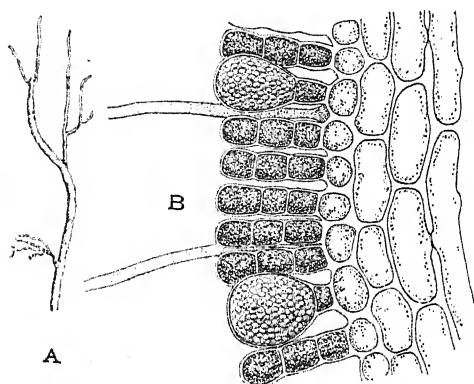


Fig. 106.—*Gobia baltica* Reinke. A. plant ($\times 3$); B. Long. sect. of thallus showing sporangia, assimilating filaments and hairs ($\times 400$).

G. baltica Reinke.

On stones and mussel-shells in the littoral region. Very rare; S. Scotland.

Family X.—**ASPEROCOCCACEÆ**

Fronds tubular or compressed, usually simple, occasionally branched; uniloc. zoosporangia in external scattered groups, composed of cylindrical paraphyses and spherical sporangia.

1. **ASPEROCOCCUS** Lamour.(Lat. *asper*, rough, and Gr. *kokkos*, a berry.)

Fronds olive-brown, simple or branched, hollow; surface cells small, containing plastids, inner cells larger and colourless. Uniloc. sporangia developed from the superficial cells of the frond, globose, sessile between the paraphyses, in groups; hairs tufted, arising from the superficial cells; pluriloc. sporangia ovoid, ellipsoid or conical.

Key.

- | | |
|----------------------------------|---------------------------|
| 1. Thallus compressed | <i>A. compressus</i> (4). |
| Thallus inflated or terete | 2. |

2. Thallus usually less than 1 cm. in diam., elongated and attenuate at the base *A. fistulosus* (2).
 Thallus 1 cm. or more in diam., sharply attenuate at the base, stalked *A. bullosus* (3).
 Thallus not more than 1 cm. long, with basal disc *A. scaber* (1).

1. **A. scaber** Kuck. Lat. *scaber*, rough.—Fronds not more than 1 cm. long, single or grouped on a basal disc; thallus at first monosiphonous, later becoming parenchymatous by intercalary growth, consisting in section of 4 central cells and

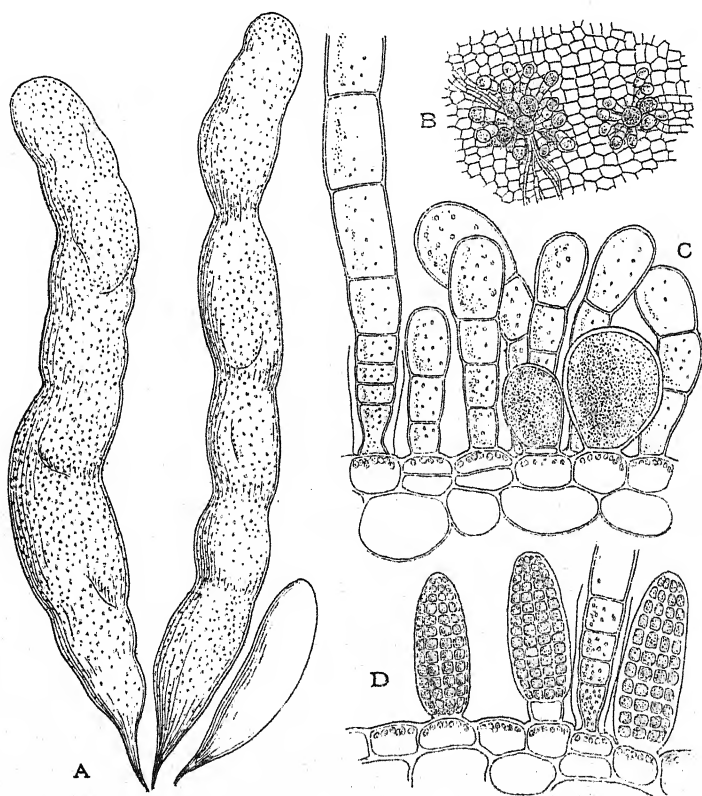


Fig. 107.—*Asperococcus bullosus* Lamour. A. ($\times \frac{3}{8}$); B. surface view showing sori ($\times 60$); C. uniloc. sporangia ($\times 300$); D. pluriloc. sporangia ($\times 300$).

a band of small cortical cells; multicellular hairs developed laterally and at the apex. Uniloc. sporang. spherical or pear-shaped; pluriloc. sporang. on the same or on separate plants, conical, elongated, scattered or in groups.

On stones in shallow water. Very rare; Weymouth and Cumbræ.

2. *A. fistulosus* Hooker. Lat. *fistulosus*, tubular.—Fronds densely tufted, 5–60 cm. long, very gradually attenuate at the base, and tapering upwards into a sharp or blunt point, cylindrical, bag-like, here and there narrowed or constricted; simple, greenish when young, then olive-brown; membranous, soft, adhering to paper when young; attached by a small disc. Globose uniloc. sporang. developed in considerable numbers in definite sori; paraphyses numerous. Annual.

In shallow pools between tide-marks, also on stones and shells. Common and abundant.

var. *vermicularis* Griff.—Frond setaceous, filiform, twisted. Not common; Devon, Hants, Durham and Northumberland.

3. *A. bullosus* Lamour. Lat. *bulla*, a bubble.—Gregarious; frond 15–30 cm. or more long, suddenly contracted at the base into a stem-like portion, 0.6–1.25 cm. long; frond simple, inflated, sac-like, occasionally constricted, membranous and sub-transparent, pale olive; soft and gelatinous when young, adhering to paper; older specimens thick, not adhering to paper. Attached by a small disc. Uniloc. sporang. in roundish patches, interspersed with numerous paraphyses. Annual.

In the sea, on stones, larger algæ and *Zostera*; also in land-locked muddy bays. Locally abundant; widely distributed.

4. *A. compressus* Griff.—Gregarious; fronds 15–45 cm. long, gradually attenuate at the base, much compressed, tubular, with sides of tube closely adpressed, united here and there by delicate filaments; pale yellowish green or olive-green, tender; surface cells minute, inner cells large and colourless. Uniloc. sporang. in oval patches with numerous paraphyses. Annual.

Epiphytic on other algæ below low-water mark. Rare; Cornwall, Devon, Dorset, Jersey and Orkneys.

2. *STRIARIA* Grev.

(Lat. *stria*, a furrow.)

Thallus terete, filamentous, tubular; cortex usually of only 2 or 3 cell-layers with thin walls; apices of branches, articulate, attenuate, ending in colourless hairs. Uniloc. zoosporangia developed in the cortical layer, spherical or ovoid.

S. attenuata Grev.—Tufted, 7.5–30 cm. long, tubular, attenuate at each extremity, clothed at intervals with branches which are beset with smaller ramuli; delicately membranous, closely adhering to paper; branches opposite or ternate, rarely scattered, ending in colourless hairs; thallus tubular, cortex of 2 or 3 rows of large thin-walled cells, the outer cells smaller and containing the plastids. Uniloc. zoosporang. formed in the outer layers, singly or in patches, which are frequently

arranged in rows on the thallus, so that a fruiting plant has an articulate appearance. Annual.

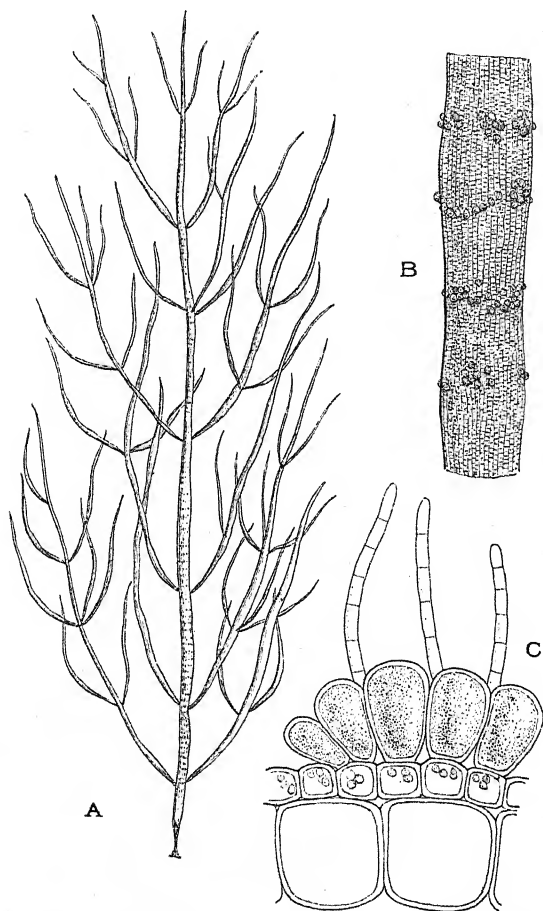


Fig. 108.—*Striaria attenuata* Grev. A. ($\times \frac{3}{8}$); B. Fertile portion ($\times 60$); C. uniloc. sporangia ($\times 300$).

Epiphytic on the smaller algæ, generally beyond the tide range. Rare; S. England, I. of Man, Bute, Orkneys and Ireland.
var. *crinita* J. G. Agardh.—Thallus 10–20 cm. long. Rare; Cornwall and Ireland.

3. MYRIOTRICHIA Harv.

(Gr. *muriōs*, innumerable, and *thrix*, a hair.)

Fronds olive-brown, filamentous, consisting of a single row of cells when young, later becoming a solid axis; branches short, radiating in all directions, formed by outgrowths from the superficial cells of the axis. Uniloc. zoosporangia spherical; pluriloc. sporangia elongated, borne on the axis between the branches; main axis and branches ending in colourless hairs.

Key.

- | | |
|----------------------------------------------------------------------------------------|----------------------------|
| 1. Plurilocular sporangia borne singly | 2. |
| Plurilocular sporangia borne in clusters | 3. |
| 2. Upper branches longer than lower, and bearing a few patent secondary branches | <i>M. clavæformis</i> (1). |
| Branches of nearly equal length, throughout | <i>M. densa</i> (3). |
| 3. Thallus microscopic, monosiphonous | <i>M. repens</i> (4). |
| Thallus 1.25 cm. or more long, polysiphonous | <i>M. filiformis</i> (2). |

1. *M. clavæformis* Harv. Lat. *clava*, a club, *forma*, shape.—Tufted, 1.25 cm. or more long, primary filament articulated, clothed with branches which are longest at the apex, giving the plant a club-shaped appearance, dark olivaceous brown, soft and delicate; central axis polysiphonous, bearing many polysiphonous branches from which numerous colourless articulated hairs arise. Uniloc. sporang. globose, sessile on the branches; pluriloc. sporang. elongated, sessile. Annual.

Epiphytic on various algæ, especially *Scytosiphon lomentarius*. Not uncommon.

var. *minima* Holm. & Batt.—Smaller than the type. Rare; Devon and Dorset.

2. *M. filiformis* Harv. Lat. *filiformis*, thread-like.—Somewhat resembling *M. clavæformis*, but differing in the form of the branches; and the arrangement of the pluriloc. sporangia, which are clustered in this species. In *M. clavæformis* the upper branches are longer than the lower, while in *M. filiformis* they are nearly equal in length throughout. Annual.

Epiphytic. Not uncommon.

3. *M. densa* Batt.—Fronds dark olive-brown, almost black, cylindrical, slightly attenuated at the base, 1.25–3.75 cm. long; axis densely clothed throughout with short, dichotomous or second level-topped more or less moniliform secondary branches, hyaline hairs few or absent. Uniloc. sporang. stalked, spherical or ovoid, pluriloc. sporang. cylindrical or lanceolate, containing one or two rows of cells.

Thickly fringing the old leaves of *Zostera marina*. Rare; widely distributed.

4. *M. repens* Hauck (*Dichosporangium repens* Hauck). Lat. *repens*, creeping.—Thallus microscopic, monosiphonous, articu-

lated, branched, ramifying in the tissues of larger algæ, particularly *Mesogloia*; branches terminating in colourless hairs. Uniloc.

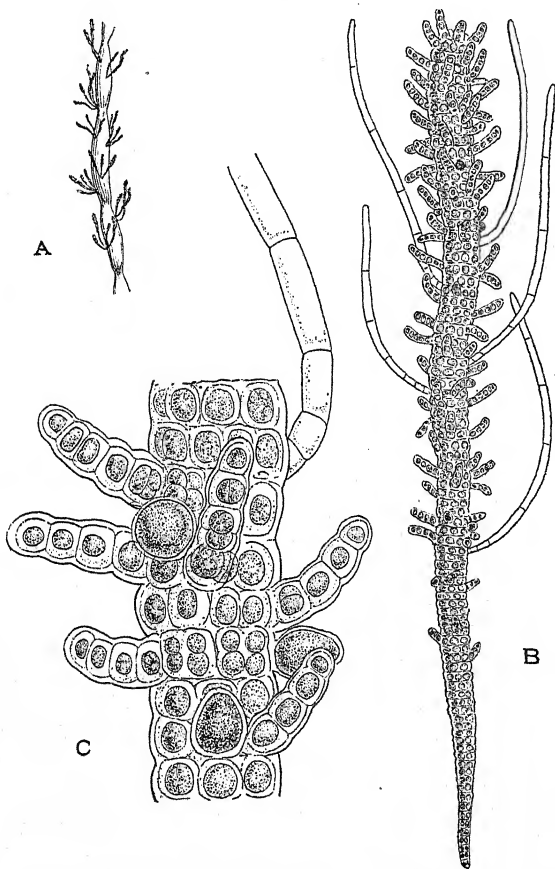


Fig. 109.—*Myriotrichia claviformis* Harv. A. On *Scytosiphon lomentarius* ($\times 1$); B. single plant ($\times 60$); C. fertile portion showing uniloc. sporangia ($\times 300$).

sporang. sessile, single or in clusters; pluriloc. sporang. in clusters at the tips of the branches.

Rare; South Coast and Scotland.

Family XI.—SCYTOSIPHONACEÆ

Thallus terete and tubular or leafy, parenchymatous. Multiloc. zoosporangia developed in large numbers in the superficial cells, covering the surface of the frond, or in more restricted areas; uniloc. sporangia not well known.

1. **PHYLLITIS** Kütz.(Gr. *phyllos*, a leaf.)

Fronds olive-brown, simple, membranous, with superficial layers of small assimilating cells and an internal zone of large colourless cells sometimes longitudinally elongated. Pluriloc. zoosporangia formed from the superficial cells consisting of 4-6 cells arranged in short filaments at right angles to the surface; uniloc. sporangia unknown; paraphyses absent.

Key.

- | | |
|------------------------------------------------------------------------------------|-----------------------------|
| 1. Strap-shaped fronds, 3-12 mm. long, arising from fibrous attachment organ | <i>P. filiformis</i> (1). |
| Disc-like attachment organ | 2. |
| 2. Narrow strap-shaped frond | <i>P. zosterifolia</i> (2). |
| Cuneiform or oval frond | <i>P. Fascia</i> (3). |

1. **P. filiformis** Batt. Lat. *filiformis*, thread-like.—Winter species forming indefinite patches, often 30 cm. or more in diam., on rocks near high-water mark; fronds strap-shaped, scarcely thicker than sewing thread, 3-12 mm. long; gregarious, arising from mass of fibrous rhizoids.

Probably not uncommon; Hants, Essex and Northumberland.

2. **P. zosterifolia** Reinke. *Zostera*, a genus of flowering plants, Lat. *folia*, a leaf.—Small slender plant with very narrow fronds 0.5-2.5 mm. broad; transverse section of narrow forms oval or oblong-oval, of the broader forms nearly linear.

In small tufts on stones in sandy pools near low-water mark. Probably not uncommon; N. England, Wales and Scotland.

3. **P. Fascia** Kütz.—Often gregarious, particularly in the lower part of the littoral region; simple, greenish or brown-olive fronds 5-30 cm. long, 1 mm. to 6 cm. broad, abruptly cuneate at the base, or much attenuated; membranous and smooth, rather glossy; margin waved or flat; superficial layer of assimilating cells, the central part of the frond being occupied with large elongated cells. Pluriloc. sporang. formed from the outer layer, consisting of short filaments closely packed at right angles to the surface.

On sand-covered submarine rocks and stones near low-water mark. Not common; widely distributed.

var. **tenuissima** Batt.—Sterile frond with slender almost translucent rounded segments, more or less lanceolate, attenuate at base and apex. Yorkshire and Orkneys.

var. **debilis** Hauck.—About 30 cm. by 3-6 cm., borne on stalk 2-3 mm. long. Rare; Cornwall and Scotland.

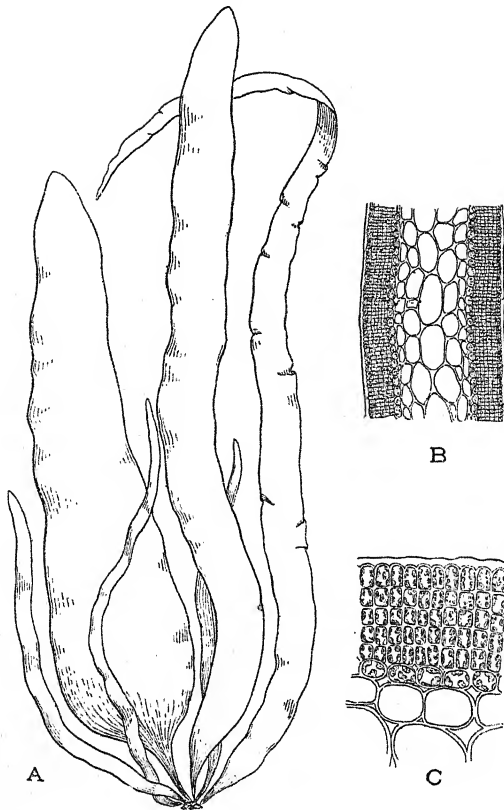


Fig. 110.—*Phyllitis Fascia* Kütz. A. ($\times \frac{2}{3}$); B. section of thallus showing pluriloc. sporangia ($\times 60$); C. pluriloc. sporangia ($\times 420$).

2. SCYTOSIPHON C. A. Agardh

(Gr. *scutos*, a whip, and *siphon*, a tube.)

Fronds simple, cylindrical, usually constricted at intervals, hollow, superficial layer of small assimilating cells, inner layer of vertically elongated cells. Pluriloc. sporangia similar to those of *Phyllitis*, but interspersed with paraphyses, except in *S. pygmæus*.

Key.

- | | |
|-------------------------------------------------------------------------------|-------------------------|
| Fronds 20–45 cm. long, pluriloc. sporangia interspersed with paraphyses | <i>S. lomentarius</i> . |
| Fronds about 1 cm. long, paraphyses absent | <i>S. pygmæus</i> . |

S. lomentarius J. G. Agardh. Lat. *lomentarius*, legume-like.—Often gregarious; fronds from 20-45 cm. long, markedly attenuate at the base, the apex ending in a blunt point; unbranched, usually constricted at intervals, tubular, brownish

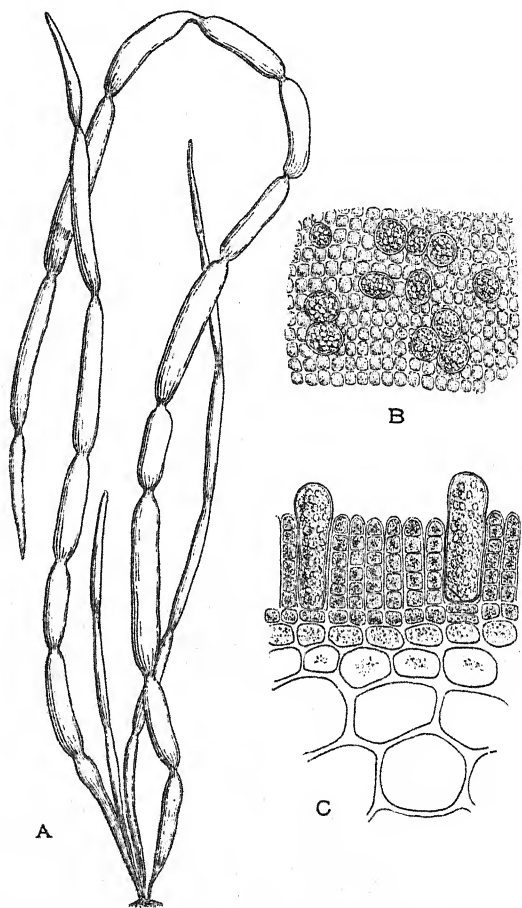


Fig. 111.—*Scytosiphon lomentarius* J. G. Agardh. A. ($\times \frac{2}{3}$); B. Surface view showing pluriloc. sporangia and large granular paraphyses ($\times 420$); C. section ($\times 420$).

green or olive, membranous and soft, adhering to paper; central cavity divided at intervals by transverse septa; attached by a disc. Multiloc. zoosporang. formed in chains from the surface layer, interspersed with ovoid or pyriform paraphyses. Annual.

On rocks, stones and smaller algæ in tide-pools. Common and abundant.

var. *zostericola* Thur.—Smaller than the type, with fewer constrictions. Sporangia in a continuous layer. On *Zostera*. Not uncommon; Dorset, Bute and Orkneys.

S. pygmæus Reinke. Lat. *pygmæus*, dwarf.—Unbranched erect filaments about 10 mm. long terminating in a hyaline hair, arising from a branched procumbent thread. Plurilocular sporang. containing 2-4 zoospores formed in large or small groups on the surface of the thallus, paraphyses absent.

Epiphytic on *Furcellaria*. Rare; Dorset.

3. STICTYOSIPHON Kütz.

(From *stiktos*, spotted, and *siphon*, a tube.)

Thallus filamentous, solid or tubular, much branched; branch apices articulated, ending in a colourless hair. Uniloc. zoosporangia in the cortical cells, completely sunk or protruding, single or grouped.

Key.

Thallus 10-60 cm. long *S. subarticulatus*.
Thallus 7.5-15 cm. long *S. tortilis*.

S. subarticulatus Hauck. Lat. *sub*, somewhat, *articulatus*, jointed.—Thallus tufted, 10-60 cm. long, upper parts thin, solid,

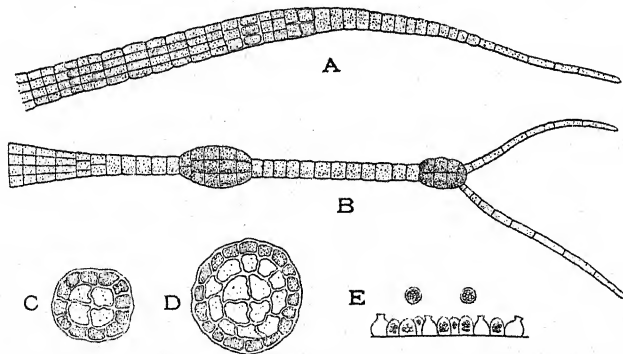


Fig. 112.—*Stictyosiphon subarticulatus* Hauck. A. Apex of the filament showing the development of cortication; B. irregular development of cortication; C. and D. Trans. sects. of young and old branches; E. Uniloc. sporangia (after Areschoug).

and much branched, lower half tubular, dirty yellow or brown; branches elongated, variable, sometimes opposite. Uniloc. sporang. half sunk in the thallus, grouped.

In shallow sandy pools between the tide-marks. Rather rare; England, Scotland, Ireland and Orkneys.

Closely resembling *Dictyosiphon fœniculaceus*, from which it may be distinguished by the transverse lines visible on the frond under a lens.

S. tortilis Reinke. Lat. *tortilis*, twisted.—Thallus tufted, 7.5–15 cm. long, usually much branched from the base, yellowish brown, becoming darker in drying; branches opposite or alternate, upper parts frequently clothed with ramuli; branches becoming detached frequently develop independently. Zoosporang. formed in the thallus.

Attached to stones, mussel shells and algæ within the littoral or sub-littoral zone. Not uncommon; Scotland and North England.

4. LITOSIPHON Harv.

(Gr. *litos*, slender, and *siphon*, a tube.)

Epiphytic either in tufts or distributed over a larger area of the host; frond cartilaginous, filiform, simple, composed of several rows of cells, solid when young, tubular later.

Key.

In tufts 0.6–1.25 cm. long on <i>Laminaria</i>	<i>L. Laminariæ</i> .
Fronds densely tufted 5–10 cm. long, clothing the host over a considerable area	<i>L. pusillus</i> .

L. pusillus Harv. Lat. *pusillus*, very small.—In dense tufts, 5–10 cm. long, completely concealing the host for several inches, unbranched, greenish at first, then brownish olive; somewhat cartilaginous but soft, closely adhering to paper; young thallus clothed with slender, byssoid, articulated hairs, older thallus hollow; filaments formed of several rows of cells, inner ones large, outer gradually smaller and containing the plastids. Uniloc. and pluriloc. zoosporang. developed in the outer layers on the surface of the thallus. Annual.

Epiphytic on *Chorda Filum*. Common.

Old fronds of *Chorda Filum* are frequently turned into shaggy slippery ropes at the end of summer by the growth of *L. pusillus*.

L. Laminariæ Harv.—In small tufts 0.6–1.25 cm. long on *Alaria esculenta*; clear olive, becoming brown with age; soft, adhering to paper; consisting of several layers of concentric cells. Uniloc. and pluriloc. zoosporang. borne on the surface of the thallus.

Subgenus *Pogotrichum* Reinke

Key.

Tufts of filaments, radiating from gall-like swellings on <i>Alaria esculenta</i>	<i>L. hibernicus</i> .
Tufts of fine unbranched filaments on <i>Laminaria</i> ...	<i>L. filiformis</i> .

L. filiformis Batt. (*Pogotrichum filiforme* Reinke).—Occurring in tufts of very fine unbranched filaments on *Laminaria*. Pluriloc. sporang. developed in the outer cells of the thallus.

Locally abundant; Dorset, Renfrew and Bute.

Var. **gracilis** Batt.—4–8 mm. long, usually composed of a

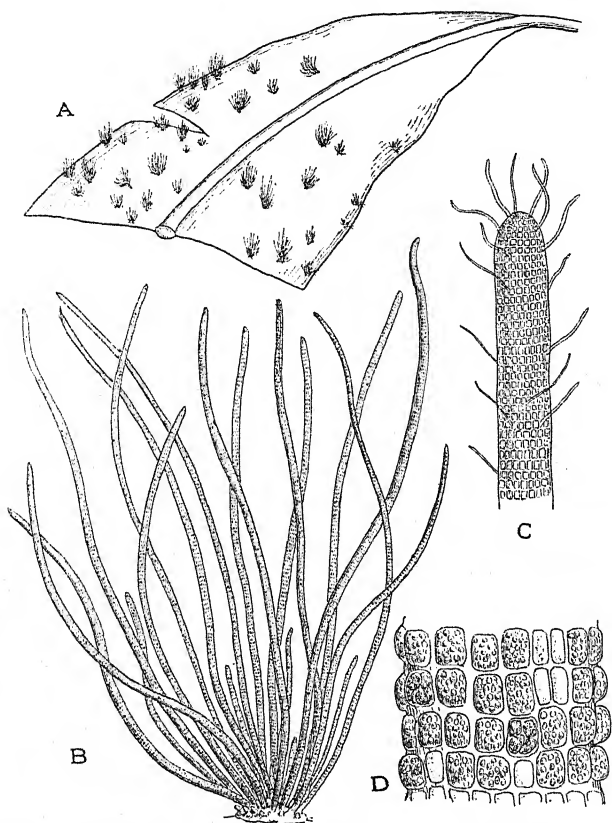


Fig. 113.—*Litosiphon Laminariæ* Harv. A. Colonies on *Alaria esculenta* ($\times \frac{2}{3}$); B. single colony ($\times 20$); C. apex of thallus ($\times 60$); D. uniloc. sporangia ($\times 300$).

single cell-row, $15\text{--}20\mu$ by $15\text{--}30\mu$, arising from a basal disc composed of one cell-layer. Renfrew.

2. **L. hibernicus** Batt. (*Pogotrichum Hibernicum* T. Johnson).—On the thallus of *Alaria esculenta* in tufts of filaments, radiating from gall-like swellings; individual tufts not more than 1 cm. long, varying from one to many cells in thickness; filaments bearing numerous hairs. Pluriloc. and uniloc. sporangia developed in the outer cells of the thallus.

5. **ISTHMOPLA** Kjellm.(Gr. *isthmos*, a neck of land, and *pleos*, full.)

This genus forms a link between *Ectocarpus* and *Pilayella*; the pluriloc. sporangia are formed in the continuity of the branches, while the uniloc. sporangia are only partially immersed in them; filaments erect, monosiphonous or partly polysiphonous.

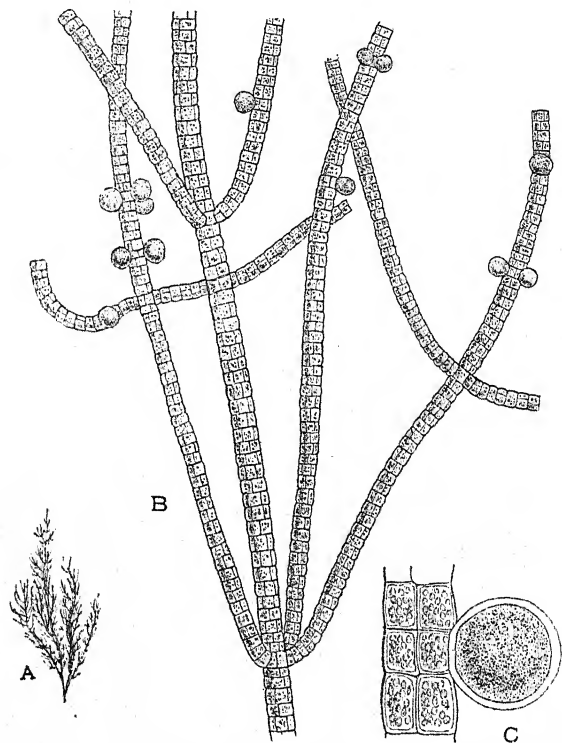


Fig. 114.—*Isthmoplea sphærophora* Kjellm. A. ($\times \frac{2}{3}$); B. showing uniloc. sporangia ($\times 60$); C. sporangium ($\times 300$).

I. sphærophora Kjellm. (*Ectocarpus sphærophorus* Carm.). Gr. *sphaira*, a sphere, *phoreo*, I carry.—Filaments tufted, 2.5–7.5 cm. long, densely branching; flaccid, adhering to paper, olivaceous or yellowish brown; main branches opposite or whorled, often polysiphonous; secondary branches opposite or alternate, monosiphonous. Uniloc. sporang. spherical, dark olive, sessile, borne on the branches, usually opposite to each other or to a ramulus; pluriloc. sporang. indefinitely extended in the

main axis and the upper branches, a few cells at the apex being usually sterile. Annual.

On *Ptilota elegans*, *Callithamnion polyspermum*, and other small algæ between the tide-marks. Not common; widely distributed.

Family XII.—PUNCTARIACEÆ

Thallus leaf-like, ribbon-like or filamentous, usually parenchymatous, sometimes tubular. Uniloc. and pluriloc. sporangia developed from superficial or sub-cortical cells, more or less sunk in the thallus, scattered or grouped.

1. *PHÆOSACCION* Farlow

(Gr. *phaios*, dark, and *sakkos*, a sac.)

Fronds olive-brown, tubular or saccate, composed of a single layer of cells disposed in fours; hairs absent. Reproduction by zoospores produced singly in each cell.

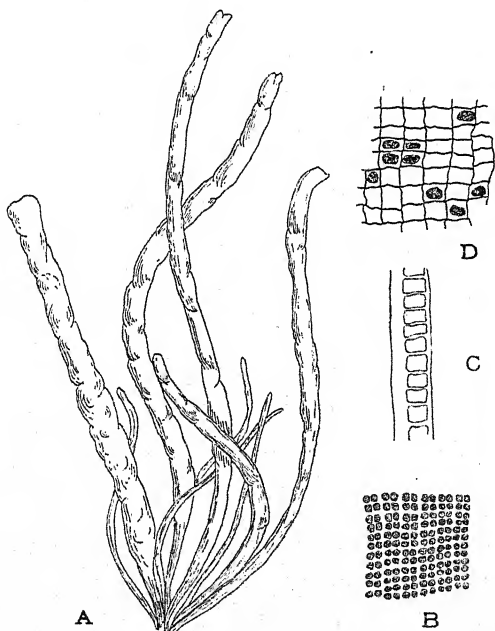


Fig. 115.—*Phæosaccion Collinsii* Farlow. A. ($\times 4$); B. surface view ($\times 100$); C. Section of thallus ($\times 230$); D. surface of thallus showing empty cells and zoospores ($\times 230$).

P. Collinsii Farlow. After F. S. Collins, American algologist.
—Thallus unbranched, gregarious, cylindrical-compressed, 0.3–2.5

cm. broad by 5–20 cm. long; at first saccate becoming cylindrical, apex at length ruptured; olive-brown, becoming greenish on drying; thallus consisting of a single row of cells with fairly regular division into 4. Single zoospore from each cell.

On *Zostera*. Very rare; Cumbrae.

2. **PUNCTARIA** Grev.

(Lat. *punctum*, a point.)

Thallus leaf- or ribbon-like, membranous, consisting of 1 or 2–6 layers of similar almost rectangular large cells; colourless hairs arising singly or in clusters from the surface cells, hairs of older parts sometimes containing plastids. Zoosporangia formed by differentiation of single surface cells, singly or in groups forming dark patches on the thallus; uniloc. zoosporangia almost spherical, multiloc. sporangia conical with a rounded apex.

Subgenus 1.—**Eupunctaria**.

Key.

- | | |
|---------------------------------------------------------------|-------------------------|
| 1. Thallus linear less than 1 cm. broad, slender | <i>P. tenuissima</i> . |
| Thallus more than 1 cm. broad | 2. |
| 2. Clear dark brown; zoosporangia in elliptical patches | <i>P. plantaginea</i> . |
| Pale; zoosporangia in round patches..... | <i>P. latifolia</i> . |

1. **P. plantaginea** Grev. *Plantago*, a genus of flowering plants.—Densely tufted, 10–30 cm. long by 0.6–5 cm. broad, lanceolate or ovate-lanceolate, more or less tapering, passing gradually into a minute setaceous stem, attached by a small disc; brownish olive; clothed when young with clusters of delicate hairs, making the plant soft and gelatinous to the touch, adhering to paper; thallus of several rows of similar almost rectangular cells. Uniloc. zoosporang. developed singly or in clusters from the surface cells of the thallus; multiloc. sporang. conical with rounded apex, borne in elongated clusters giving the plant a punctate appearance. Annual.

On rocks and stones between the tide-marks and in rocky tide-pools and on algæ. Not uncommon.

var. **Crouani** Thur.—Smaller than the type, linear or linear-lanceolate, green when dry. Bute.

var. **rubescens** Batt.—Somewhat thicker than the type, slightly lacinate. Bute and Orkneys.

2. **P. latifolia** Grev. Lat. *latifolius*, broad-leaved.—Forming tufts 20–40 cm. long, 2.5–7.5 cm. wide; thallus unbranched, oblong or lanceolate, flat or wavy, generally obtuse at both extremities, occasionally tapering, olive-green; thallus of several layers of similar cells. Sporangia single or in roundish groups. Annual.

Rocks and stones in the sea. Not common; widely distributed.

var. **lanceolata** Batt.—Thallus markedly lanceolate, or in the adult with an obtuse apex, the base attenuate into a very slender stipe. Devon and Hants.

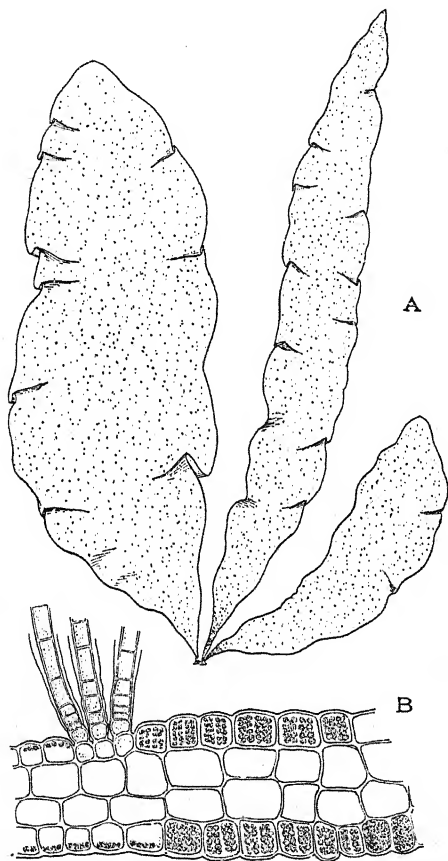


Fig. 116.—*Punctaria latifolia* Grev. A. ($\times \frac{3}{4}$); B. Section of thallus showing sporangia ($\times 300$).

var. **laminarioides** Holm. & Batt.—Thallus narrow-obovate or wedge-shaped. Rare; Cornwall, Devon and Bute.

3. *P. tenuissima* Grev. Lat. *tenuissimus*, most slender.—Densely tufted, 5–20 cm. long, less than 1 cm. broad; thallus tapering at the base and apex, but linear for the greater part of

its length, sometimes ending bluntly, margin often wavy, entire or slightly serrate, pale brownish olive, sometimes almost hyaline, thin and delicate, adhering to paper. Zoosporangia in patches, mixed with filamentous hairs. Annual.

On *Zostera marina*, *Chorda Filum* and other algæ, near low-water mark. Locally abundant; widely distributed.

Subgenus 2.—*Desmotrichum* Kütz.

Thallus an unbranched ribbon, attenuate at base and apex, 2-4 cell-layers thick, hairs present in the early stages. Uniloc. sporangia scattered, sunk in the thallus; pluriloc. sporang. scattered, conical or fusiform, produced in groups on the surface, attached by short pedicels, or formed directly from cortical cells, and immersed in the thallus.

Key.

Fronds 5-20 cm. long, densely tufted with waved margin	<i>P. undulata</i> .
Fronds 1-10 mm. long, mono- or polysiphonous	<i>P. baltica</i> .

P. undulata J. G. Agardh (*Desmotrichum undulatum* Reinke).—Fronds 5-20 cm. long, densely tufted, unbranched, attenuate at the base and apex, margin wavy, and either entire or slightly toothed, pale horn-colour, almost hyaline, thin, adhering to paper. Uniloc. sporang. occurring singly, or rarely in groups, developed from the cortical cells; pluriloc. sporang. conical, in groups, usually formed on the surface, but occasionally actually immersed in the thallus. Annual. Summer.

On *Zostera* and *Chorda Filum* near low-water mark. Bute and Orkneys.

P. baltica Batt. (*Desmotrichum balticum* Kütz.).—Frond simple, monosiphonous when young, later becoming polysiphonous by a series of longitudinal divisions, bearing hairs at the apex, 1-10 mm. in height. Pluriloc. sporang. usually arising laterally from the base of the frond, but sometimes intercalary.

On *Zostera* and various algæ. Dorset.

Subgenus 3.—*Phycolapathum* Kütz.

P. crispata Batt. (*Phycolapathum crispatum* Kütz., *P. debile* Kütz., *Punctaria laminarioides* Crouan).—Frond olive-green, rigid, lanceolate or broadened, irregularly split, margin curled; leafy portion formed of superficial polygonal cells, and internal cells of variable size; attached by minute disc.

Locally abundant; Scilly Islands.

3. **PHLÆOSPORA** Aresch. emend. Reinke(Gr. *phloios*, bark, and *spora*, seed.)

Thallus branched, filamentous, frequently hollow at the base, solid above; superficial cells small and angular, inner cells longitudinally elongated. Uniloc. sporangia developed from the cortical cells; zoospores liberated in a mucilaginous mass from the apex of the sporangium; anterior cilium distinct, posterior rarely visible.

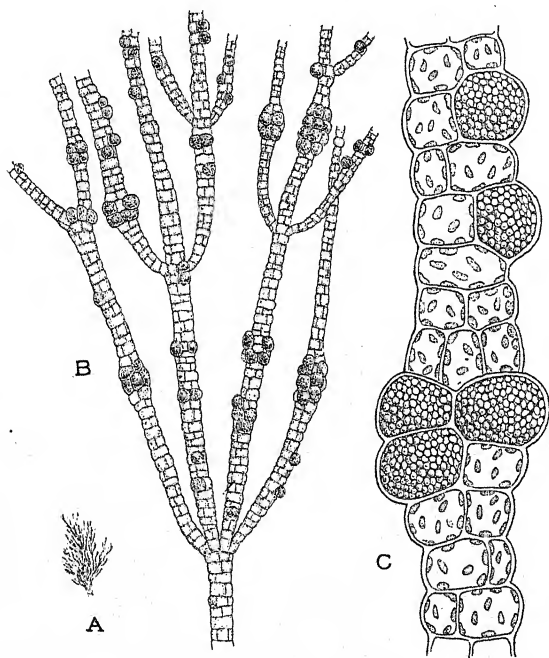


Fig. 117.—*Phlæospora brachiata* Born. A. ($\times \frac{1}{2}$); B. uniloc. sporangia ($\times 60$); C. ($\times 300$).

P. brachiata Born. (*Ectocarpus brachiatus* Harv., *Stictyosiphon Griffithsianus* Holm. & Batt.). Lat. *brachiatus*, having widely spread branches.—Finely tufted, 5–10 cm. high, main filaments slightly entangled, excessively branched, all branches opposite or quaternate; upper parts with opposite ramuli. Uniloc. sporang. usually borne in groups, sometimes arising at the nodes of the branches sunk in the thallus.

Epiphytic on *Rhodymenia palmata*. Rather rare; South Coast, Channel Islands, Scotland and Ireland.

Order II.—SPHACELARIALES

Thallus usually much branched, with erect conspicuous apical cells and very regular branching. In *Sphacelaria* and *Cladostephus* the branches are formed from initial cells below the apical cells, although hairs may arise by direct division of the apical cells. In *Stypocaulon* branches are formed by direct division of the apical cell.

Family I.—SPHACELARIACEÆ

Fronds branching, polysiphonous, terminating in a large apical cell, often with a cortex formed of densely interwoven rhizoidal filaments. Uniloc. and pluriloc. sporangia spherical or ellipsoidal, borne on the branches.

1. SPHACELARIA Lyngb.

(Gr. *sphakelos*, gangrene.)

Fronds olive-brown, filamentous, branching, lower parts frequently clothed with attachment rhizoids; axis and branches ending in a large apical cell, from which a solid frond is formed by transverse and longitudinal divisions; external layer of rectangular cells arranged in regular transverse bands. Uniloc. and pluriloc. sporangia spherical or ellipsoidal on short pedicels; vegetative reproduction by modified branches (*propagula*).

Key.

- | | |
|----------------------------------------------------------------------|----------------------------|
| 1. Branching pinnate | 2. |
| Branching not pinnate | 4. |
| 2. Epiphytic on smaller algæ | <i>S. cirrhosa</i> var. |
| In sandy pools or beneath <i>Zostera</i> | <i>pennata</i> (6). |
| 3. Unilocular sporangia pyriform | 3. |
| Unilocular sporangia globose | <i>S. plumula</i> (8). |
| 4. Articulations $1\frac{1}{2}$ to twice as long as broad | <i>S. plumigera</i> (9). |
| Articulations about equal in length and breadth | <i>S. tribuloides</i> (4). |
| 5. Tufts 1 cm. or less high on Fucaceæ or Laminariaceæ | 5. |
| Tufts more than 1 cm. high | 6. |
| 6. On Laminariaceæ, simple or with one or two branches | 7. |
| On Fucaceæ, sparsely branched from the base ... | <i>S. cœspitula</i> (7). |
| 7. Unilocular sporangia in crowded racemes on special branches | <i>S. furcigera</i> (5). |
| Unilocular sporangia not in racemes | <i>S. racemosa</i> (3). |
| 8. Filaments felted below owing to interlacing of branches | 8. |
| Filaments not felted | <i>S. olivacea</i> (2). |
| | <i>S. radicans</i> (1). |

1. *S. radicans* Harv. Lat. *radicans*, rooting.—Filaments 1.25–2.5 cm. long, erect or decumbent, forming dense irregular tufts, never felted; branches few, irregular, either alternate or second, straight, destitute of ramuli, articulated throughout, and usually bearing rhizoids from their lower parts; greenish

olive, rigid, not readily adhering to paper; articulations rather shorter than broad, longitudinally striate, false cortex absent. Unilocular sporangia ovoid or spherical, scattered or clustered on the main branches.

On sand-covered rocks, between the tide marks. Not uncommon; widely distributed.

2. *S. olivacea* Pringsh.—Filaments decumbent, felted below by the interlacing branches, forming indefinitely expanded tufts, rhizoidal filaments numerous; branching irregular, with wide angles between the branches. Sporangia ovoid or globose, borne on short pedicels of one to three cells.

On the walls of caves, and in the shade of overhanging rocks near high-water mark. Rather rare; widely distributed.

3. *S. racemosa* Grev. Lat. *racemosus*, clustering.—Tufted, 2.5 cm. high, olivaceous, somewhat rigid, the fronds dichotomous; articulations equal in length and breadth. Uniloc. sporang. ovoid, racemose, pedunculate.

Very rare; Berwick, Edinburgh and Bute.

4. *S. tribuloides* Menegh. Lat. *tribulus*, a caltrop, Gr. *eidos*, like.—Forming tufts 1–2 cm. high; filaments arising from a basal cell layer or having the lower parts clothed with rhizoids, irregularly branched; branches erect, growing point of the lateral branches first club-shaped, then wedge-shaped with three horns, owing to the formation of propagula; articulations 1–1½ times as long as broad. Pluriloc. sporang. usually unilateral, ovoid, borne on a short stalk.

On stones and larger algæ. Very rare; Scotland.

5. *S. furcigera* Kütz., var. *saxatilis* Kuck. Lat. *furca*, a two-pronged fork, *gero*, I produce.—Forming tufts 2–10 mm. high, on Fucaceæ, attached by procumbent filaments and rhizoids which penetrate the host; erect filaments sparingly branched, often bearing colourless hairs. Uniloc. sporang. ovoid or spherical on a one-celled stalk; pluriloc. sporang. elongate, on a stalk of two or more cells.

Very rare; Dorset.

6. *S. cirrhosa* C. A. Agardh, var. *pennata* Hauck. Lat. *cirrhosus*, with tendrils.—Forming dense tufts, filaments 0.6–5 cm. long, with variable branching, more or less regularly pinnate; olive, becoming brown with age; rigid, not adhering to paper; pinnæ opposite, irregular in length, but gradually becoming shorter near the tips; articulations throughout, about equal in length and breadth. Uniloc. and pluriloc. sporang. sessile or shortly stalked, scattered along the pinnæ.

Epiphytic on the smaller algæ, between the tide-marks. Common and abundant.

var. *irregularis* Hauck.—Main branches irregular, secondary branches unilateral. Rather rare; Dorset and Hants.

var. *patentissima* Grev.—Ramuli irregular, arising at right angles. Rather rare; Dorset, Sussex and Bute.

var. *fusca* Holm. & Batt. (*S. fusca* Harv.)—Ramuli cruciform, scattered. Rather rare; widely distributed.

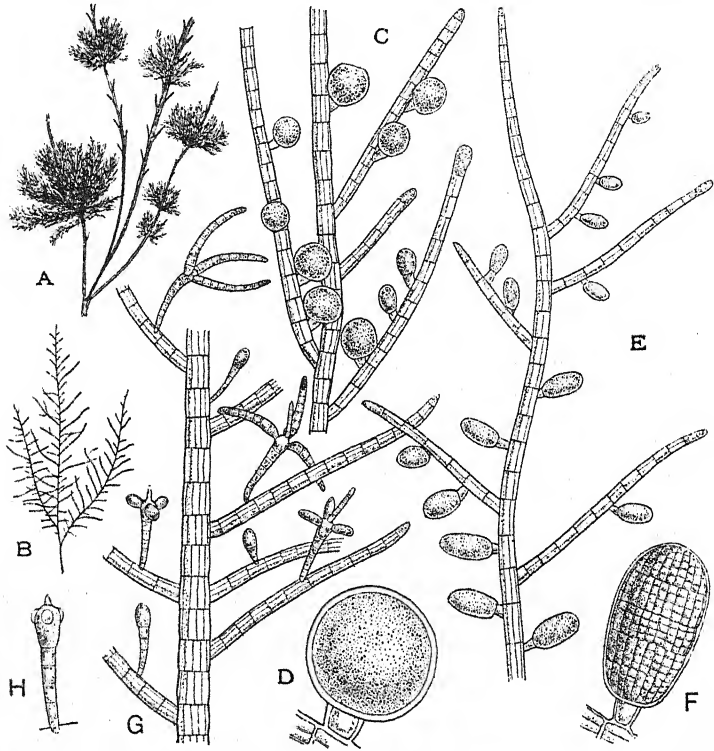


Fig. 118.—*Sphacelaria cirrhosa* C. A. Agardh. A. Colonies on host ($\times \frac{2}{3}$); B. thallus ($\times 2$); C. uniloc. sporangia ($\times 60$); D. single uniloc. sporangium ($\times 180$); E. pluriloc. sporangia ($\times 60$); F. single pluriloc. sporangium ($\times 180$); G. thallus with propagula ($\times 60$); H. single propagulum ($\times 120$).

var. *ægagropila* Griff.—Forming a dense round ball. Not uncommon.

It is often difficult to separate plants of *S. cirrhosa* from those of *S. radicans*. In the latter the secondary branches are never opposite, in *S. cirrhosa* they are frequently opposite.

7. *S. cæspitula* Lyngb. Lat. *cæspitula*, a little clump.—Tufts small and scattered, filaments 1.5–3 mm. high, either simple or with one or two short simple branches near the apices; articulations slightly broader than long. Pluriloc. sporang. large

and ovoid, second on the inner sides of the filaments, very numerous, borne on short pedicels of 3 cells.

On the stipe of *Laminaria Cloustoni*. Very rare.

8. *S. plumula* Zanard. (*S. pseudoplumosa* Holm.).—1-2 cm. high, much branched, branches opposite, pinnate, clothed with pinnate ramuli; articulations as long as broad. Uniloc. sporang. pyriform, borne on the ramuli.

On the substratum in the *Zostera* zone. Rare; widely distributed.

9. *S. plumigera* Holmes (*S. plumosa* Harv., *pro parte*). Lat. *pluma*, the downy part of a feather, *gero*, produce.—Tufted, 5-15 cm. high, setaceous, naked below, irregularly much branched above; olivaceous or rusty, rigid; not adhering to paper; branches alternate or secund, or frequently fasciculate; ramuli opposite, arising from each articulation.

In shallow sandy pools between tide-marks, usually near low-water mark.

Rather rare; locally abundant.

This species has been confused with *Sphacelaria plumosa*, which has sporangia on special stichidia arising from the main axis, and is really a *Chaetopteris*. *S. plumigera* is a true *Sphacelaria*, with globose, shortly pedicellate, unilocular sporangia borne on the plumose secondary branches.

2. BATTERSIA Reinke

(After E. A. L. Batters, British algologist.)

Encrusting; similar in habit to *Ralfsia*, the upper cell-layer bearing sori. Uniloc. sporangia borne at the apices of simple or laterally branched erect filaments.

B. mirabilis Reinke. Lat. *mirabilis*, wonderful.—Forming a crust, up to 4 cm. thick; basal layers parenchymatous, growing

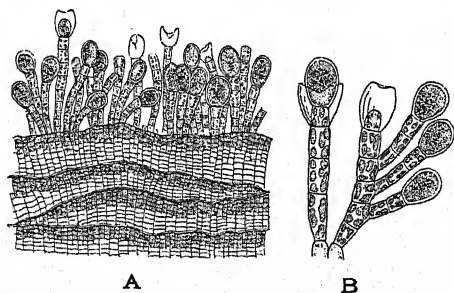


Fig. 119.—*Battersia mirabilis* Reinke. A. section of thallus with sorus ($\times 80$); B. group of uniloc. sporangia ($\times 130$).

from marginal apical cells; thallus simple, then of several superimposed layers, each consisting of a number of cell-filaments adhering to form a parenchymatous tissue. Reproductive organs in sori projecting from the surface of the uppermost layer;

uniloc. sporang. sessile or shortly stalked, borne on erect filaments projecting from the surface of uppermost layer.

On stones. Very rare; Berwick.

3. *SPHACELLA* Reinke

(Gr. *sphakelos*, gangrene.)

Axis monosiphonous, lateral branches never arising from the apical cell, ramuli absent.

S. subtilissima Reinke. Lat. *subtilissimus*, most slender.—

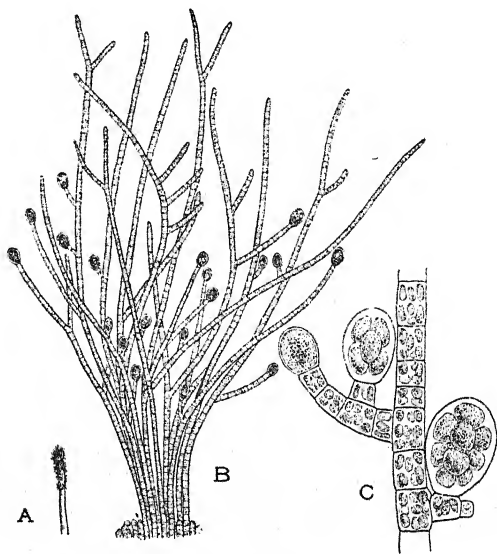


Fig. 120.—*Sphacella subtilissima* Reinke. A. Colonies on *Carpomitra Cabrerae* ($\times 3$); B. showing uniloc. sporangia ($\times 50$); C. ($\times 80$).

Thallus monosiphonous, in tufts about 1 mm. high; branching irregular, basal part expanded or filamentous, ramifying among the tissues of the host. Uniloc. sporang. ovoid, shortly stalked, lateral or terminal on the axis and branches.

On *Carpomitra Cabrerae*. Very rare; Plymouth.

4. *CHÆTOPTERIS* Kütz.

(Gr. *chaite*, a bristle, and *pteron*, a wing.)

Frond filiform, branched; branches bearing two rows of opposite pinnae; cortex well developed, formed of interwoven filaments; differing from *Sphacelaria* by the special branches arising from the cortical layer of the main axis, which bear the sporangia, and from *Cladostephus* by the opposite branches.

C. plumosa Kütz. (*Sphacelaria plumosa* Harv., *Cladostephus plumosus* Holmes). Lat. *plumosus*, feathered.—Fronds slender, 5–10 cm. or more long, irregularly branched, the base of the stem as well as the branches being naked for a short distance; opposite pinnæ long and closely set, arising from every joint below, or in the plumose upper half from every other joint.

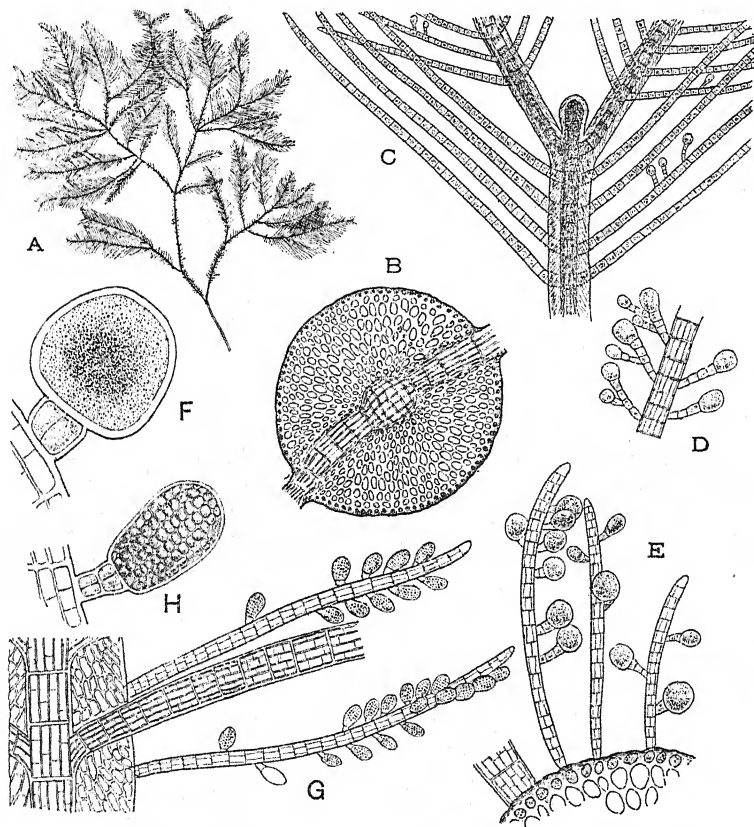


Fig. 121.—*Chaetopteris plumosa* Kütz. A. ($\times \frac{3}{4}$); B. Trans.-sect. ($\times 60$); C. thallus ($\times 30$); D. uniloc. sporangia ($\times 90$); E. stichidia with uniloc. sporangia ($\times 60$); F. uniloc. sporangium ($\times 420$); G. stichidia with pluriloc. sporangia ($\times 60$); H. pluriloc. sporangium ($\times 420$).

Sporangia on short stichidia arising usually from the cortical layer of the main axis; uniloc. sporang. globose, plurilocular oblong ovoid, both kinds shortly pedicellate and mostly secund on the upper side of fruit-bearing branches; stichidia usually numerous around the denuded portions of the main stem.

In deep water beyond tide-marks. Rather rare; widely distributed.

Family II.—CLADOSTEPHACEÆ

Fronds branching, polysiphonous, terminating in a large apical cell, corticate except near the apex; secondary branches whorled. Uniloc. and pluriloc. sporangia on special branchlets growing from the axis, between the insertion of the ordinary whorls.

CLADOSTEPHUS J. G. Agardh

(From *klados*, a shoot, and *stephos*, a crown.)

Fronds branching, secondary branches whorled, growth apical; main axes densely corticate by growth of rhizoidal filaments, secondary branches ecorticate, hairs in tufts just below the apices of the branches. Uniloc. and pluriloc. sporangia stipitate on special branches.

Key.

Whorls of ramuli very close together, difficult to differentiate	<i>C. spongiosus.</i>
Whorls of ramuli close but distinct	<i>C. verticillatus.</i>

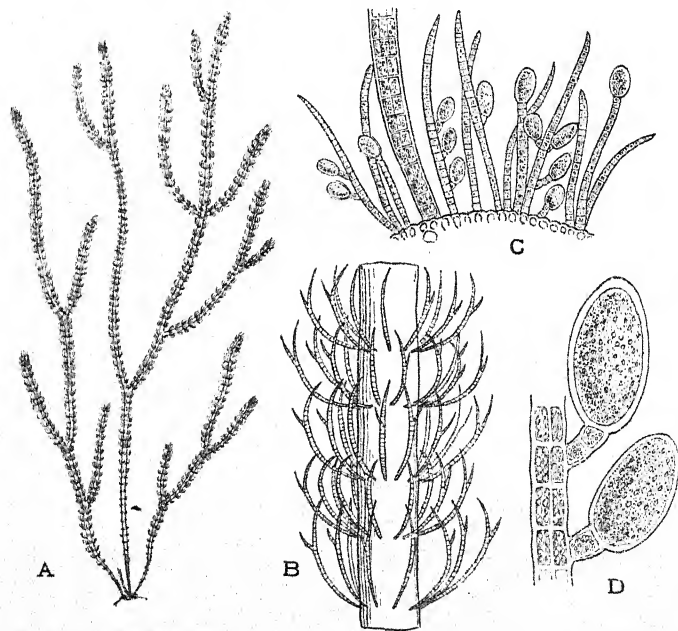


Fig. 122.—*Cladostephus verticillatus* J. G. Agardh. A. ($\times 3$); B. portion of thallus ($\times 12$); C. Trans. sect. showing uniloc. sporangia ($\times 60$); D. uniloc. sporangia ($\times 300$).

C. spongiosus J. G. Agardh. Fronds 4–10 cm. long, primary filaments more or less branched, with whorls of ramuli, completely covering the thallus; dull brown or olive-green; woody, not adhering to paper; secondary branches usually destitute of hairs and spine-like branchlets. Uniloc. sporang. shortly stalked on special branches.

On rocks and stones between tide-marks and at a greater depth. Common.

C. verticillatus J. G. Agardh.—12–25 cm. long, slender, sub-dichotomous; secondary branches distinctly whorled, falcate, acute at the apex, attenuate at the base, furnished externally with a few spine-like branchlets; hairs numerous, dark olive. Uniloc. sporang. globose or nearly so; pluriloc. sporang. elongated on short pedicels on special branches growing from the axis between the insertions of the secondary branches.

On rocks, stones and corallines in the tide range. Very common.

Family III.—STYPOCAULACEÆ

Branches formed by direct division of the apical cell, in a similar manner to the formation of the hairs in *Sphacelaria* and

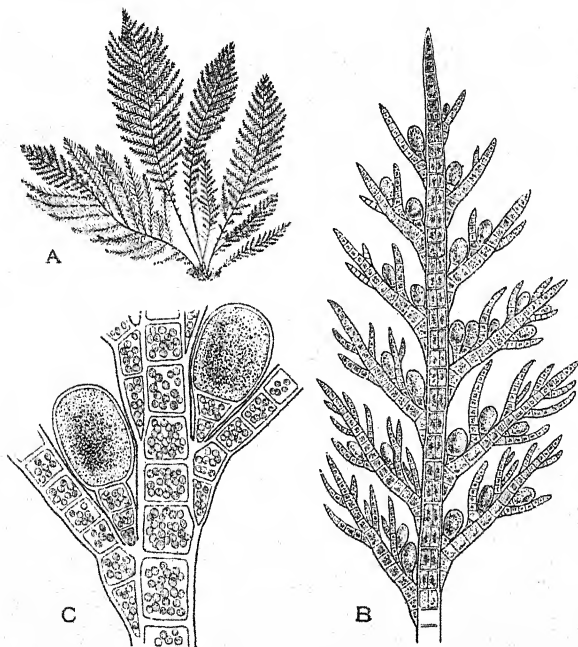


Fig. 123.—*Halopteris filicina* Kütz. A. ($\times \frac{2}{3}$); B. showing uniloc. sporangia ($\times 60$); C. the same ($\times 300$).

Cladostephus; fronds branching, corticate in the lower parts. Uniloc. and pluriloc. sporang. on the branches.

1. HALOPTERIS Kütz.

(Gr. *hals*, the sea, and *pteron*, a wing.)

Frond much branched, pinnate. Sporangia borne singly on the secondary branches and ramuli.

H. filicina Kütz. (*Sphacelaria filicina* C. A. Agardh). Lat. *filicinus*, fern-like.—Frond 5–10 cm. long, much branched, naked at the base, or clothed throughout with multipinnate branchlets; greenish olive, substance rigid, scarcely adhering to paper; central axis consisting in section of 4 large cells, surrounded by a band of cortical cells. Uniloc. and pluriloc. sporang. ovoid, sessile or very shortly stalked, in the axils of the smaller branchlets.

On rocks and nullipores near low-water mark and on the haptera of larger algæ. Rare; widely distributed.

var. **sertularia** Batt. (*H. filicina* Kütz., var. *patens* Harv.).—Branches and ramuli very patent. Very rare; widely distributed.

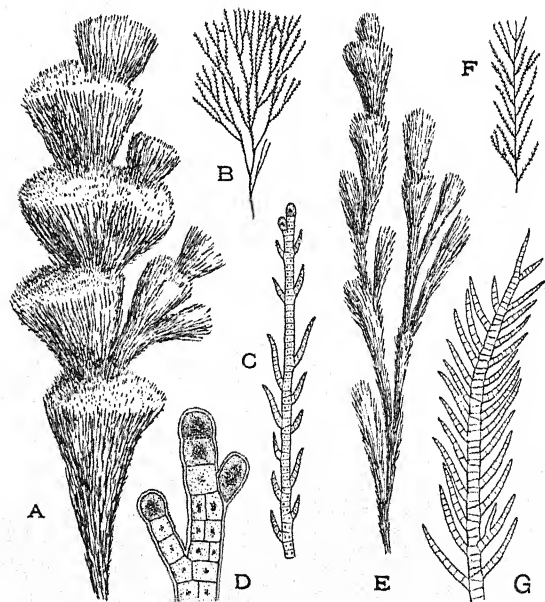


Fig. 124.—*Stypocaulon scoparium* Kütz. A. Plant in summer ($\times \frac{3}{8}$); B. Portion ($\times 1$); C. ($\times 60$); D. uniloc. sporangia ($\times 300$); E. Plant in winter ($\times \frac{3}{8}$); F. Portion ($\times 1$); G. ($\times 60$).

2. **STYPOCAULON** Kütz.

(Gr. *stupa*, the coarse part of flax, and *kaulos*, a stem.)

Frond much branched, pinnate, central axis consisting of a number of cuboidal cells surrounded by a wide band of corticating cells. Fertile branches with numerous uniloc. sporangia in groups in the axils.

S. scoparium Kütz. Lat. *scoparius*, a sweeper.—Tufted, 8–15 cm. high; thallus multipinnate, clothed almost throughout with corticating cells; summer form shaggy, individual tufts having the form of inverted cones; winter form regularly pinnate, resembling *Halopteris flicina* in outward appearance. Uniloc. sporang. in groups, on long pedicels in the axils of the fertile branchlets.

On submerged rocks between the tide-marks and in deeper water. Common S. England; local and scarce N. England and Scotland.

var. **scoparioides** Holm. & Batt. (*Sphacelaria scoparioides* Lyngb.).—Branches and ramuli alternate, very patent. Rare.

Order III.—CUTLERIALES

Thallus with trichothallic growth. Zoospores on diploid, gametes on haploid individuals; oogamous.

Family.—CUTLERIACEÆ

Fronds ribbon-like or forming discs, erect or procumbent, margin entire or irregularly lobed, membranous or leathery, growth trichothallic, structure parenchymatous. Oogonia and antheridia in sori on the surface of the thallus; uniloc. sporangia. in sori on the upper surface of the thallus. Dioecious.

1. **CUTLERIA** Grev.

(After Catherine Cutler, British algologist.)

Thallus erect, flattened, fan-shaped; margin entire, once or repeatedly dichotomous, membranous; apices clothed with a tuft of jointed hairs. Sori developed on both sides of the thallus. Oogonia and antheridia borne on separate plants. After fertilisation or parthenogenesis, oospores give rise to the *Aglaozonia* stage, a horizontally expanded thallus, fixed to the substratum by a number of rhizoids and bearing sessile uniloc. sporangia in sori or scattered on the upper surface. Sporangia on germination give rise to the *Cutleria* stage.

C. multifida Grev. Lat. *multifidus*, many cleft.—Thallus 10–40 cm. long; cartilaginous, at first crisp, but becoming flaccid, foxy olive. Antheridia sessile, elongated and narrow, borne

laterally singly and in groups on fertile hairs arising from the surface of the thallus; oogonia each containing eight oospores in sori on the thalli of different individuals. The female plants are more frequent than the male.

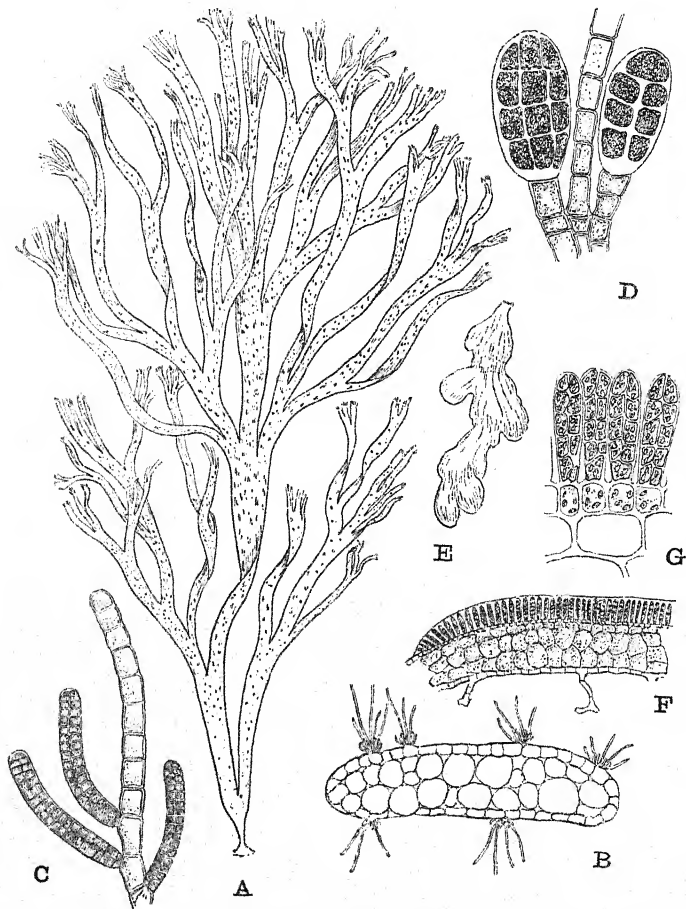


Fig. 125.—*Cutleria multifida* Grev. A. ($\times \frac{2}{3}$); B. Trans. sect. ($\times 35$); C. antheridia ($\times 300$).; D. oogonia ($\times 300$); E. *Aglaozonia* stage ($\times 2$); F. Trans. sect. of *A. reptans* Crouan with sporang. ($\times 35$); G. portion of the same ($\times 300$).

On rocks and shells in 4-15 fathoms. Rare; widely distributed.

var. *angustifrons* Holm. & Batt.—Thallus much narrower than the type, without fan-like character. Rare.

ASEXUAL FORM—**AGLAOZONIA** Zanard.

A. reptans Crouan (*Zonaria parvula* Grev.).—Thallus delicate, membranous, several layers thick, horizontally expanded, bearing numerous rhizoids on the under side. Uniloc. sporang. elongated, sessile, in sori, without paraphyses; zoospores normally produce *Cutleria* plants.

On rocks and stones in the sea. Not uncommon; widely distributed.

2. **ZANARDINIA** Nardo

(After G. Zanardini, Italian algologist.)

Thallus horizontally expanded, flat, roundish, attached to the substratum by numerous rhizoids, membranous or leathery; formed of many cell layers, inner cells large, the outer smaller forming an assimilating layer on the upper side; surface cells in radial rows. Sori on the upper surface of the thallus; oogonia and antheridia in one sorus; uniloc. sporangia developed on a separate plant.

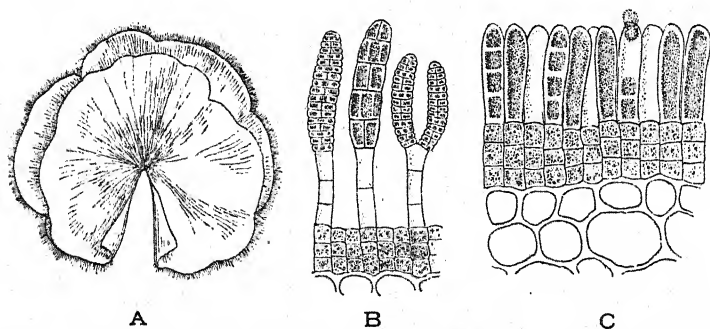


Fig. 126.—*Zanardinia collaris* Crouan. A. ($\times \frac{2}{3}$); B. oogonia and antheridia ($\times 300$); C. uniloc. sporangia ($\times 300$).

Z. collaris Crouan. Lat. *collare*, a collar.—Thallus 4–20 cm. broad, membranous, first brownish olive, round or kidney-shaped; margin entire or radially split, the edge bearing long gelatinous filaments; later, leathery, blackish brown, irregularly split, with worn naked edge; upper surface smooth, under surface felted. Oogonia and antheridia in the same sorus, at first single and terminal on a simple filament; later sometimes on short branched filaments; uniloc. sporang. containing 4–6 zoospores on a different individual. Normally the generations alternate regularly.

Very rare; Jersey and Guernsey.

Order IV.—LAMINARIALES

Sporophytic diploid generation large and conspicuous; gametophytic haploid generation small and filamentous. Sporophyte with well-formed tissue differentiated into zones. Growth intercalary.

Family I.—CHORDACEÆ

Thallus terete, unbranched, clothed in summer with filamentous hairs. Zoospores on germination giving rise to a microscopic gametophyte bearing antheridia or oogonia; fertilised egg giving rise to conspicuous generation.

CHORDA Stackh.

(Lat. *chorda*, a cord.)

Fronds olive-brown, attached by a disc, simple, hollow with diaphragms at intervals; cells of the tubular portion elongated, hexagonal in section, lined on the inside with narrow elongated cells which form the diaphragms; surface clothed with club-shaped paraphyses at right angles to the elongated cells. Sporangia ellipsoid, developed between the paraphyses.

Key.

Paraphyses club-shaped.....	<i>C. Filum.</i>
Paraphyses linear	<i>C. tomentosa.</i>

C. Filum Lamour. *Filum*, Caspar Bauhin's generic name for the plant.—Fronds gregarious, cartilaginous, mucilaginous, 65–800 cm. long, 0.6 cm. in diam., attenuate at the base; densely clothed with hyaline hairs in summer. Paraphyses slightly longer than the sporangia. Gametophyte generation a branched prothallus, the male plant being larger than the female.

On rocks and stones in sandy pools near low-water mark. Common and abundant.

var. **thrix** Hooker.—10–12 cm. long, much thinner than the type. Probably common; widely distributed.

var. **subtomentosa** Aresch.—Smaller than the type, with yellowish hairs. Probably common; widely distributed.

C. tomentosa Lyngb. (*C. Filum* Lam., var. *tomentosa* Harv.). Lat. *tomentosus*, woolly.—A rare species characterised by elongated linear paraphyses, shorter than the sporangia. Fronds always more or less covered with coloured hairs.

On rocks in deep water beyond the influence of the tides.

var. **subfulva** Foslie.—Smaller than the type, with tawny hairs, zoosporang. sub-elliptical or oblong-linear. Rare; Bute.

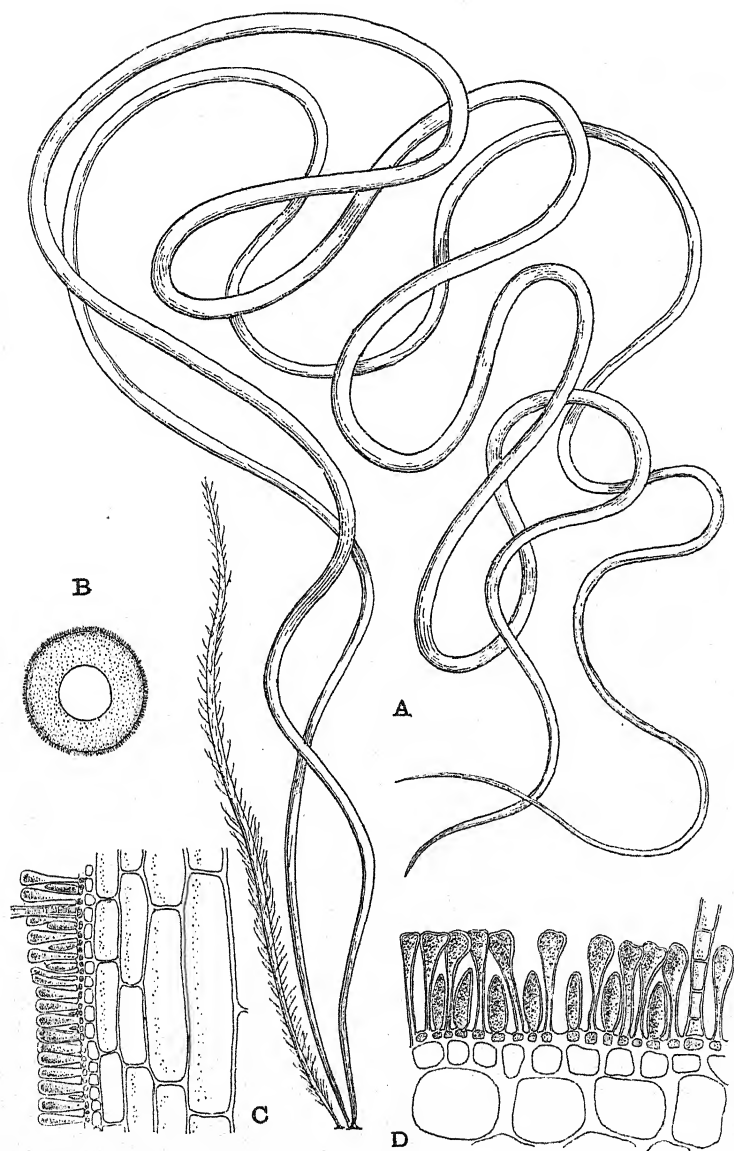


Fig. 127.—*Chorda Filum* Lamour. A. ($\times 1$); B. Trans. sect. ($\times 4$); C. portion of the same with paraphyses and sporang. ($\times 60$); D. ($\times 300$).

Family II.—LAMINARIACEÆ

Fronds large and coarse, attached by root-like processes, with a stipe and an expanded lamina, which is renewed annually in many species; internal differentiation into medullary tissue, cortical layer and assimilating layer. Uniloc. sporangia interspersed with clavate or wedge-shaped paraphyses in broad bands, or large irregular spots, or covering the whole surface of the frond; zoospores germinating to form a filamentous prothallus bearing the sexual organs; fertilised egg giving rise to diploid plant.

1. LAMINARIA Lamour.

(Lat. *lamina*, a thin plate or leaf.)

Thallus expanded, mid-rib absent, stipe more or less elongated, cylindrical or slightly compressed. Uniloc. sporangia forming bands or sori in the central part of the lamina, growth intercalary, a new expanded portion forming annually between the upper part of the stipe and the base of the blade.

Key.

- | | |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 1. Expanded portion linear lanceolate | 2. |
| Expanded portion oval, more or less digitate | 3. |
| 2. Fronds smooth, or with a row of shallow depressions; fructification forming a continuous band down the centre of the frond | <i>L. saccharina</i> (1). |
| Fronds with 4 or 5 rows of deep bullations and depressions; fructification in patches down the centre of the frond | <i>L. hieroglyphica</i> (2). |
| 3. Stipe erect, stiff, rugose, abruptly expanding into the digitate lamina, attachment fibres short and thick, not horizontally expanded | <i>L. Cloustoni</i> (4). |
| Stipe flexible, expanding gradually into the lamina, attachment fibres spread horizontally from the base of the stipe | <i>L. digitata</i> (3). |

1. *L. saccharina* Lamour. Lat. *saccharinus*, sugary.—Attached by branching fibres, stipe terete, somewhat swollen in the middle, solid, 7.5–120 cm. long; lamina deep olive, elongated, cartilaginous, lanceolate, fusiform or cuneate at the base, undivided or irregularly cleft with a row of depressions on each side, margin wavy. Uniloc. sporang. forming a continuous band, uninterrupted by the bullations, down the centre of the frond. Perennial.

Attached to rocks and stones near low-water mark, and to a depth of 5–10 fathoms. Very common and abundant.

var. *caperata* Farlow.—Stipe long in proportion to the lamina. Bute.

var. *latissima* Turn. (*L. latifolia* J. G. Agardh).—Frond wide, nearly orbicular. Rare.

var. *Phyllitis* Le Jol. (*L. Phyllitis* Lamour.).—Fronds thin, yellowish brown, margin slightly wavy, base of lamina fusiform.

Usually growing where there is a constant stream of salt water running between rocks. Not uncommon; widely distributed.

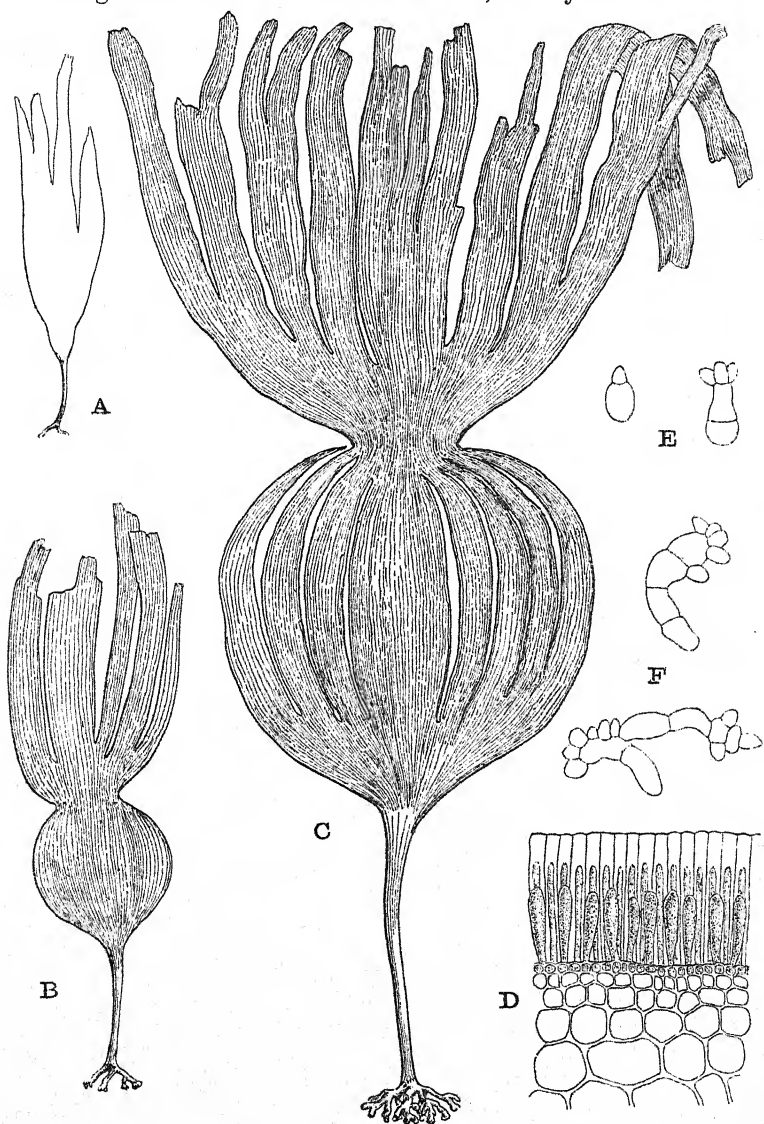


Fig. 128.—*Laminaria Cloustoni* Edmondst. A. Young plant ($\times \frac{1}{3}$); B. Older plant with intercalary growth ($\times \frac{1}{16}$); C. Adult plant ($\times \frac{1}{16}$); D. Trans. sect. of fertile portion with sporangia and paraphyses ($\times 300$); E. and F. Male prothalli of *Saccorhiza bulbosa* De la Pylaie ($\times 400$); after Sauvageau.

var. *linearis* J. G. Agardh.—Lamina rugose, long and narrow. Rather rare; Hants and Essex.

2. *L. hieroglyphica* J. G. Agardh (*L. saccharina* Lamour., var. *bullata* auct., *pro parte*).—Frond stipitate, coriaceous or membranous, attached by branching fibres, stipe terete, 5–30 cm. long, lamina elongated, lanceolate, more or less bullate when young, later with 4 or 5 rows of alternate bullations and deep depressions; margins wavy. Uniloc. sporang. appearing first on the elevated portions, gradually spreading to the depressions, giving a blotchy appearance to the lamina.

On rocks and stones near low-water mark. Common; North-East Scotland.

3. *L. digitata* Lamour.—Attached by branching, horizontally spreading fibres; stipe terete, 130–400 cm. long., attenuate upwards, gradually expanding into a leathery oval frond, deeply cleft into many linear segments. Uniloc. sporang. in small oval or roundish sori, scattered at wide intervals over the blade, not confluent; mucilage glands absent. Perennial.

On rocks at and beyond low-water mark, extending to a depth of about 15 fathoms. Common and abundant.

Distinguished from *L. Cloustoni* by smooth stipe, absence of mucilage glands, and distribution of sporangia.

var. *stenophylla* Harv.—Stipe slender; lamina wedge-shaped, tapering at the base. Rather rare; N. England, Scotland and N. Ireland.

var. *ensifolia* J. G. Agardh (*L. ensifolia* Kütz.).—Sectors of the frond sword-shaped. Rare.

var. *valida* Foslie.—Stipe nearly cylindrical, thick below, attenuate above; base of lamina rounded. Probably not uncommon.

4. *L. Cloustoni* Edmondst. (*L. hyperborea* Foslie, *L. digitata* Phyc. Brit. *pro parte*). After the Rev. C. Clouston, Orcadian naturalist.—Thallus 60–360 cm. long; stipe erect, stiff, rugose, expanding abruptly into the oval frond, deeply cleft into linear segments; mucilage canals present in the stipe, and concentric layers of tissue at the base, probably showing annual growth; attachment fibres short and thick, not spread at right angles to the stipe, but usually bent downwards at a short distance from it. Uniloc. sporang. in large indefinite patches on the surface of the blade.

On rocks and stones at low-water mark and below. Common; widely distributed.

2. SACCORHIZA De la Pyl.

(Gr. *sakkos*, a sack, and *rhiza*, a root.)

Attached at first by a disc, later by a large warty structure which begins to form above the disc and finally envelops it; stipe compressed, with a spiral twist above the swollen base,

gradually developing a wavy-curved margin, several cm. wide; expanded portion oblong, deeply cleft into many linear segments. Uniloc. sporangia in large sori on the expanded portion of the frond and the wavy margin of the stipe. Male prothallus filamentous, female prothallus often unicellular.

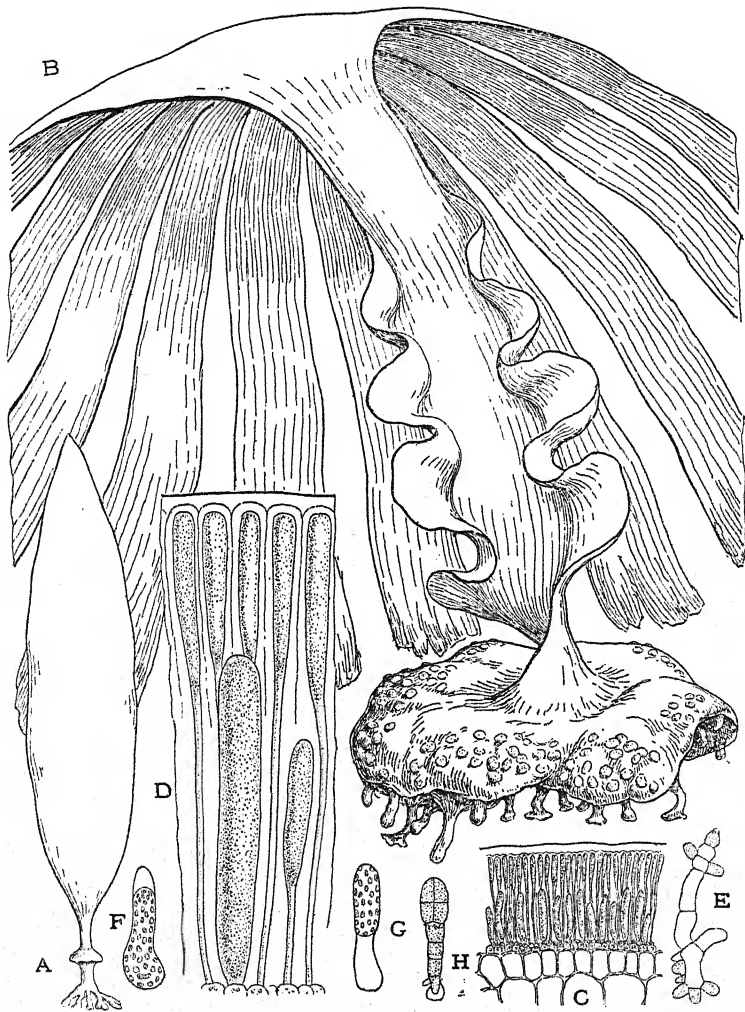


Fig. 129.—*Saccorhiza bulbosa* De la Pyl. A. Young plant ($\times \frac{1}{2}$); B. mature plant ($\times \frac{1}{10}$); C. section showing uniloc. sporangia ($\times 60$); D. sporangia and paraphyses ($\times 300$); E. Male prothallus with antheridia ($\times 400$); F. female prothallus with plastids ($\times 300$); G. the same with developing oogonium ($\times 300$); H. Young germing ($\times 125$); (E.—G. after Sauvageau).

S. bulbosa De la Pyl.—Fronde stipitate, coriaceous or membranous, undivided or irregularly cleft, midrib absent. Sori most abundant on the waved margin of the stipe; zoospores germinating to form a male or female prothallus bearing antheridia or oozonia, the fertilised egg giving rise to a diploid plant.

On rocks at low-water mark, and to a depth of about 15 fathoms. Not uncommon; widely distributed.

3. *ALARIA* Grev.

(Lat. *ala*, a wing.)

Attached by a number of branched attachment fibres, stipitate, membranaceous, with a distinct midrib. Uniloc. sporangia in special lateral leafy bodies below the lamina, with unicellular paraphyses between the sporangia. Alternation of generations, the sexual plants being protonemal.

A. esculenta Grev.—Stipe cylindrical, or somewhat compressed, 10–30 cm. long, 0.6–1.25 cm. wide, midrib solid, scarcely wider than the stipe, lamina 65–650 cm. long, decurrent on the stipe, margin wavy; growth intercalary, the lamina being gradually renewed from the base, but not shed annually as in *Laminaria*. Fructiferous leafy bodies numerous, shortly stipitate, 7.5–20 cm. long, 1.25–5.0 cm. broad, linear-ovate or linear-spathulate. Zoospores germinating to form male and female prothalli, which are larger than those of *Laminaria*. Sometimes the female prothallus is reduced to one cell, but more frequently 2 or 4 cells are formed, the terminal one becoming fertile first.

On rocks near low-water mark, always submerged. Abundant; rather local.

Formerly *A. esculenta* was eaten by the people of Scotland, Ireland, Iceland, Faeroese, and Denmark. Turner, in his "Historia Fucorum" (1809), writes: "This plant is much eaten in Scotland; the parts employed for that purpose are the midrib stripped of its membrane, which is extremely sweet, and the thick part of the pinnæ, which are called Keys. It goes by the name of Daberlocks."

Order V.—TILOPTERIDALES

Branched filaments, usually monosiphonous, similar to the Ectocarpales. Asexual generation bearing quadrinucleate monospores; sexual generation with oogonia and antheridia. Probably a regular alternation of generations occurs, the sporophyte and gametophyte being morphologically alike.

Family.—TILOPTERIDACEÆ

A small group, represented by three genera, characterised by large quadrinucleate non-motile monospores. *Acinetospora* forms monosiphonous filaments throughout, *Haplospora* and

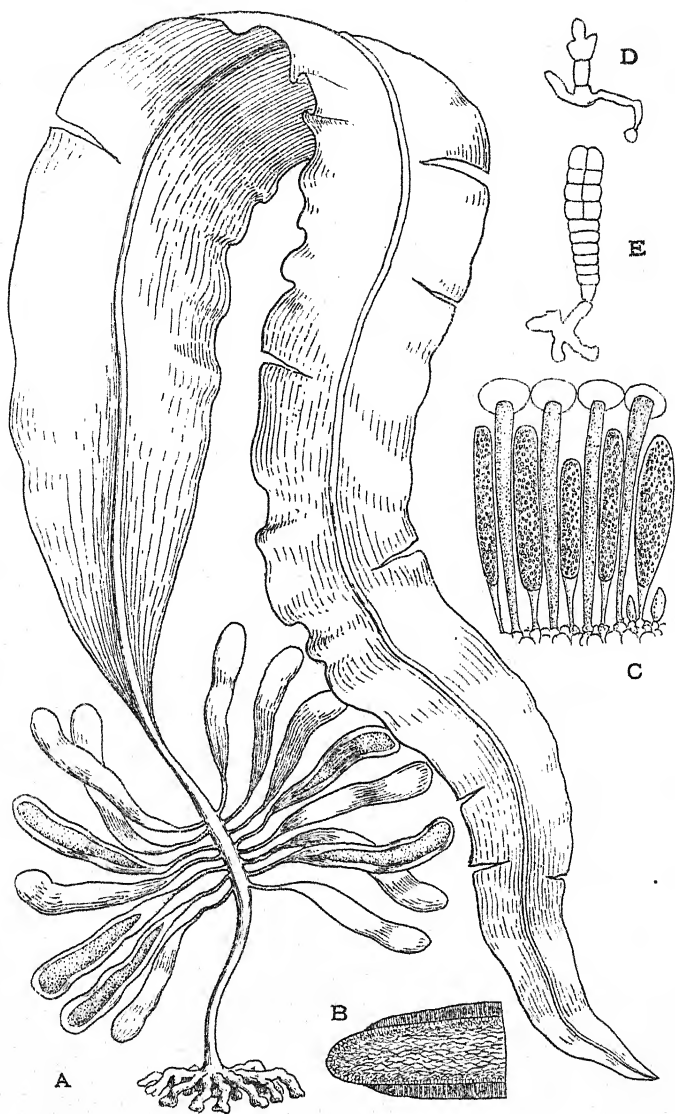


Fig. 130.—*Alaria esculenta* Grev. A. ($\times \frac{1}{2}$); B. Section through reproductive organ bearing uniloc. sporangia ($\times 16$); C. uniloc. sporangia and paraphyses ($\times 300$); D. female prothallus ($\times 120$); E. germling ($\times 150$). (D. and E. after Sauvageau).

Tilopteris are polysiphonous in the lower parts. Monospores, "unilocular sporangia" and "plurilocular sporangia" have been described in all three genera. Although Brebner recorded a plant of *Halospora globosa* bearing all three kinds of reproductive organs, this was probably an abnormality, and presumably in *Tilopteris* and *Haplospora*, oogonia and antheridia are borne on one plant and quadrinucleate monospores on another, probably giving alternation of generations. In *Acinetospora uniloc.* sporangia give rise to ciliated zoospores, and pluriloc. sporangia also produce ciliated bodies which have been observed to germinate without fusion. Quadrinucleate monospores are also formed.

1. HAPLOSPORA Kjellm.

(Gr. *haplos*, simple, and *spora*, a seed.)

Fronds filiform, monosiphonous above, more or less polysiphonous below; branches issuing irregularly from all sides of

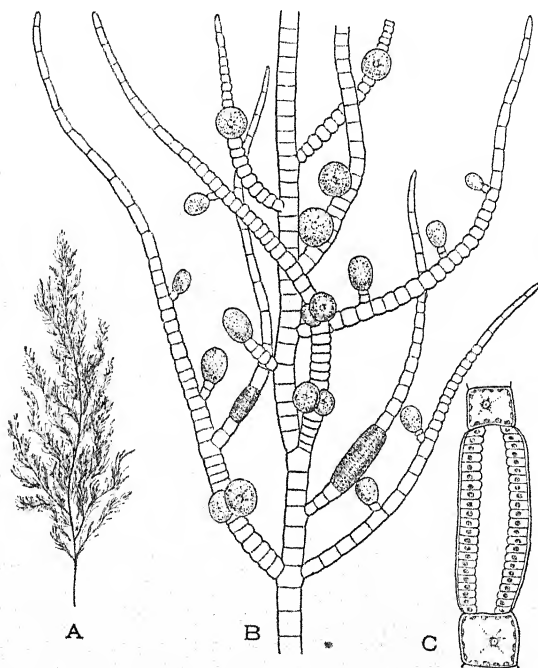


Fig. 131.—*Haplospora globosa* Kjellm. A. ($\times 3$); B. thallus showing oogonia and antheridia ($\times 60$); C. antheridia ($\times 300$).

the main axis, growth trichothallic. Asexual reproduction by non-motile quadrinucleate spores formed singly in terminal

stalked, sessile or rarely intercalary sporangia; sexual reproduction by spherical oogonia, partly immersed in the frond, and intercalary tubular antheridia, formed by the transformation of one or more cells in the continuity of the filament; sperm mother cells forming the wall of the antheridial tube. Individuals usually either asexual or hermaphrodite, though one sporo-hermaphrodite plant has been recorded.

H. globosa Kjellm. emend. Breb. (*H. globosa* Kjellm., *Scaphospora speciosa* Kjellm.).—Tufted, 2.5–30 cm. long; rich brown, turning olive-green on drying; densely branched, branches and

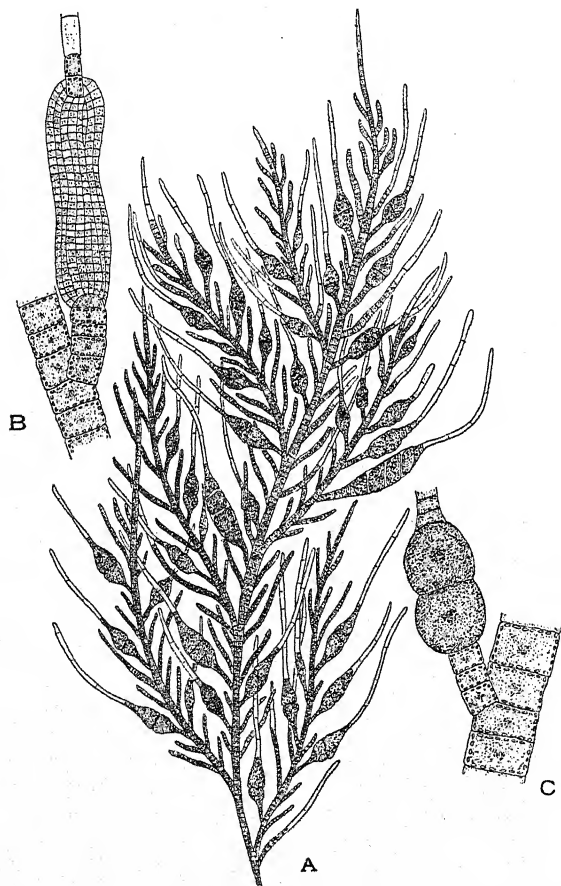


Fig. 132.—*Tilopteris Mertensii* Kütz. A. ($\times 9$); B. intercalary antheridia ($\times 270$); C. intercalary oogonia ($\times 270$).

branchlets opposite, alternate, subsecund or scattered; attached by rhizoids. Monospores globose, usually on one or many-celled stalks, more rarely sessile or intercalary; oogonia spherical, slightly flattened at the base, partly immersed in the frond; antheridia intercalary, tubular, 30–150 μ by 28–50 μ .

Very rare; Cumbrae.

2. TILOPTERIS Kütz.

(Gr. *tilos*, a fine thread, and *pteron*, a wing.)

Fronds filiform, monosiphonous in the upper parts, polysiphonous at the base, branches opposite, of unequal length, mostly undivided, closely set with slender opposite ramuli. Asexual reproduction by quadrinucleate monospores; sexual reproduction by intercalary oogonia and tubular antheridia, with probable alternation of generations.

T. Mertensii Kütz. (*Ectocarpus Mertensii* Harv.). After F. C. Mertens, German algologist.—Fronds densely tufted, but not matted together, 5–30 cm. long; clear brown-olive when young, becoming darker later; flaccid, adhering to paper; primary branches furnished with a second or third series of short branchlets, clothed with opposite ramuli which terminate in a long hair in young specimens. Reproductive organs all intercalary in development, borne in the ramuli. Annual.

On mud-covered rocks and stones near low-water mark and at greater depths. Rare; widely distributed.

3. ACINETOSPORA Born.

(Gr. *akinetos*, motionless, and *spora*, seed.)

Fronds filiform, monosiphonous throughout, forming tufts more or less interwoven, slender, sub-simple or sparingly branched, flexuose or somewhat zigzag; branches unequal in length, naked or with a few scattered ramuli. Reproduction by quadrinucleate monospores, lateral or intercalary in development, and also by uniloc. and pluriloc. sporangia borne laterally on the filament.

A. pusilla Born. (*Ectocarpus pusillus* Harv.). Lat. *pusillus*, very small.—Filaments forming interwoven tufts, 7.5–15 cm. long, slender, monosiphonous; greenish olive when young, gradually becoming pale brown; membranous, not closely adhering to paper; articulations of the main branches rather longer than broad, slightly narrower at the nodes. Annual.

Epiphytic on smaller algæ. Rather rare; widely distributed.

var. **crinita** Batt. (*Ectocarpus crinitus* Carm.).—Articulations 2 or 3 times as long as broad. On muddy seashores. Rare : widely distributed.

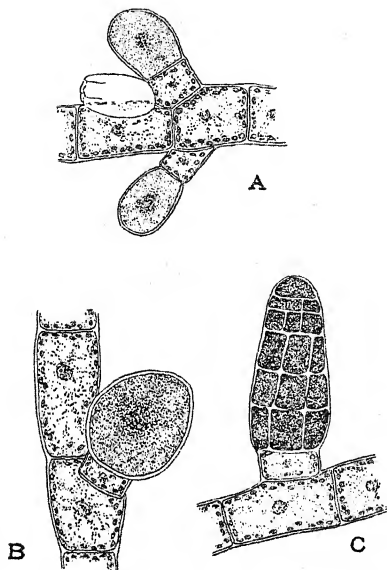


Fig. 133.—*Acinetospora pusilla* Born. A. monospores and empty sporangium; B. young uniloc. sporangium; C. pluriloc. sporangium ($\times 270$).

Order VI.—DICTYOTALES

Thallus usually expanded, with apical growth. Asexual reproduction by non-motile naked spores, four of which are formed in each sporangium ; sexual organs on the surface of the thallus, female gametes non-motile. Alternation of generations, the two generations being similar in form.

Family.—DICTYOTACEÆ

Thallus leafy, olive-green, parenchymatous. Asexual reproduction by tetraspores, sexual reproduction by oogonia and antheridia, sometimes borne on separate plants ; oogonia spherical or ovoid ; antheridia elongated, borne in a sorus.

1. DICTYOTA Lamour.

(Gr. *diktuotos*, net-like.)

Thallus flat, dichotomously branched, large cells within bounded by a single layer of small cells in longitudinal rows ;

growth from an apical cell, which divides to form dichotomous branches ; hairs in groups on both surfaces of the thallus.

Key.

Branches attenuate at the base *D. ligulata*.
Branches not attenuate at the base..... *D. dichotoma*.

***D. dichotoma* Lamour.** Gr. *dichotomos*, divided equally.—Thallus 7.5–30 cm. long, dichotomously branched, forming ribbons 3–12 mm. in width, main axis cuneate at the base, ultimate

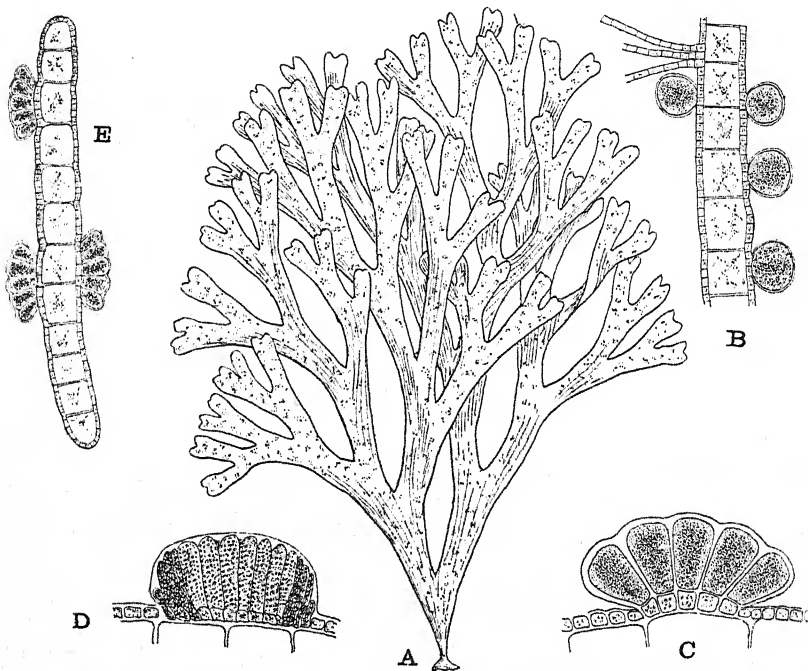


Fig. 134.—*Dictyota dichotoma* Lamour. A. ($\times \frac{3}{4}$); B. Trans. sect. of thallus with young tetraspores ($\times 40$); C. Trans. sect. of oogonial sorus ($\times 300$); D. Trans. sect. of antheridial sorus ($\times 300$); E. Trans. sect. showing arrangement of oogonial sori ($\times 40$).

branches about equal in length, delicately membranous, olivaceous towards the tips.

Common and abundant ; S. and W. England and S. and W. Ireland ; much less abundant, and local, E. England and Scotland.

var. *implexa* J. G. Agardh (var. *intricata* C. A. Agardh).—Frond very narrow, much branched, twisted and entangled. Not uncommon.

var. *latifrons* Holm. & Batt.—Broader than the type. Not uncommon.

D. ligulata Kütz.—Thallus 7.5 cm. or longer, branching irregularly dichotomous; unbranched or once divided near the base; upper portions either dichotomous or several branches arising from the same point, gradually attenuate at the base, spathe-like at the apex. Fructification in irregular patches on the surface of the frond.

Rare; Devon and Dorset.

2. **TAONIA** J. G. Agardh

(Gr. *taonios*, of a peacock.)

Thallus flattened, without midrib, irregularly branched, tips of the branches truncate. Asexual reproduction by tetraspores, sexual reproduction by oogonia and antheridia, borne on separate

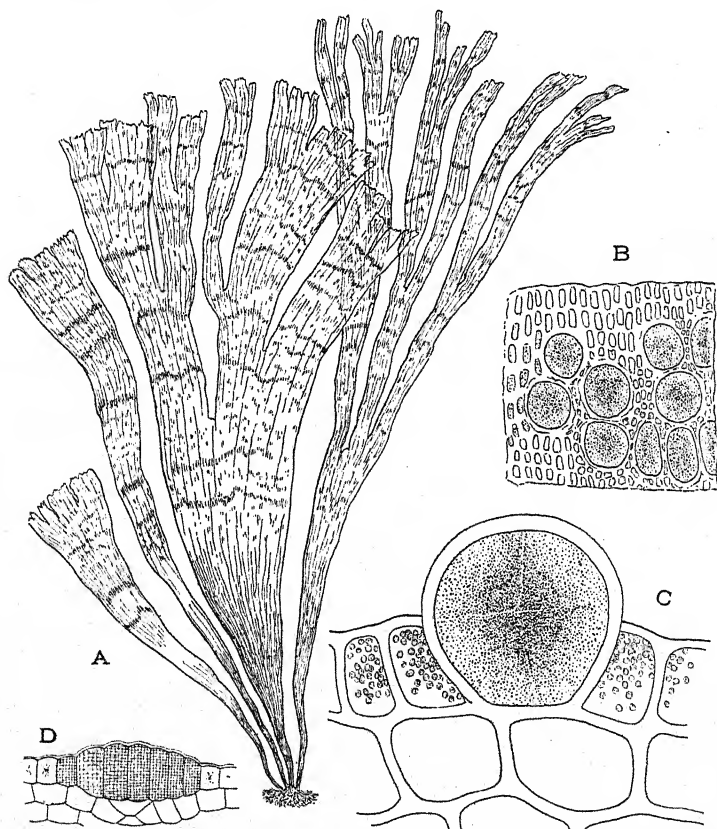


Fig. 135.—*Taonia atomaria* J. G. Agardh. A. ($\times \frac{2}{3}$); B. surface view showing tetraspores ($\times 130$); C. section of thallus showing tetrasporangium ($\times 300$); D. Antheridia of *T. Solieri*. (After Derbès.)

plants; hairs and reproductive organs borne on both surfaces of the thallus, in concentric zones.

T. atomaria J. G. Agardh. French *atomaire*, with scattered, coloured dots.—Fronds clustered, 7.5–30 cm. long, 1.25–7.5 cm. wide, delicately membranous, translucent, glossy, broadly wedge-shaped, variously cleft from the apex downwards, lateral margins either entire or dentate, pale olive-green above, becoming darker towards the base. Hairs and reproductive organs in wavy transverse bands, giving the frond a zonate appearance.

Locally abundant, S. and E. England and Cardigan Bay; very rare, Scotland and Ireland.

var. *divaricata* Holm. & Batt.—More divaricate than the type. Rare; South Coast.

3. **PADINA** Adans.

(Gr. *padinos*, belonging to a plain.)

Thallus flattened, leafy, without midrib, simple or divided, inner parts formed of several layers of colourless cells, bounded on each side by a single layer of assimilating cells. Hairs and

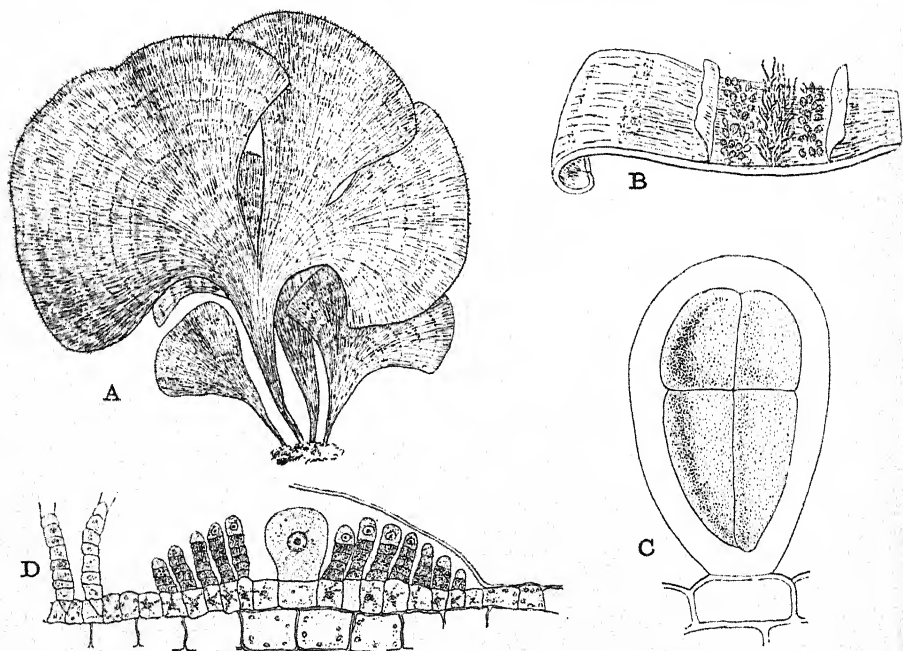


Fig. 136.—*Padina pavonia* Gaillon. A. ($\times \frac{1}{2}$); B. Portion of thallus with rolled margin and reproductive organs ($\times 10$); C. Single tetrasporangium ($\times 300$); D. Section of thallus with antheridia and oogonium ($\times 50$).

reproductive organs borne on one side of the thallus, in concentric zones; antheridia formed in a longitudinal series of cells at right angles to the zones of oogonia.

P. pavonia Gaillon. Lat. *pavo*, a peacock.—Fronds tufted, 5-12.5 cm. high, cuneate and attenuate at the base, broadly fan-shaped upwards, simple or cleft, gradually acquiring a curved outline; apical margin rolled, thick, leathery below,

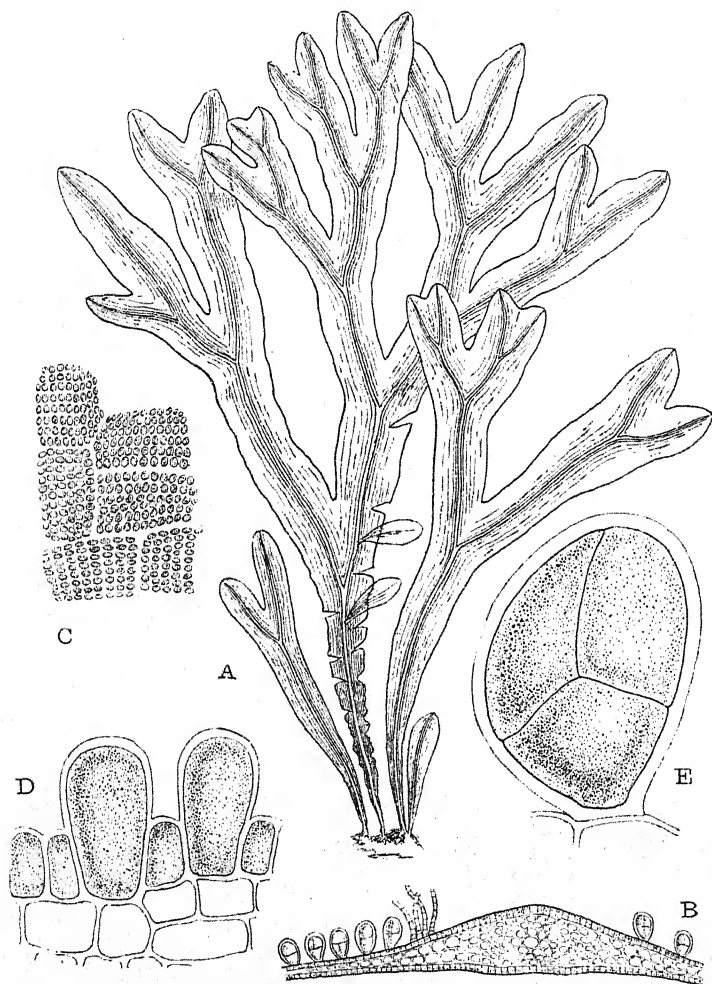


Fig. 137.—*Dictyopteris membranacea* Batt. A. ($\times \frac{3}{8}$); B. Trans. sect. of thallus ($\times 30$); C. surface view showing antheridia ($\times 300$); D. oogonia ($\times 300$); E. tetrasporangium ($\times 300$).

membranous above; upper surface smooth, except for orange filaments which more or less completely fringe the concentric bands, yellowish olive, becoming reddish towards the base and greenish towards the apex; lower surface covered with white chalky powder in concentric zones.

Locally abundant, S. England and Channel Islands.

4. **DICTYOPTERIS** Lamour.

(Gr. *diktuon*, a net, and *pteron*, a wing.)

Midrib prominent, forming a stem-like thallus at the base, persisting throughout the plant even when the lamina is torn away. Branching dichotomous, clusters of hairs and reproductive organs on both surfaces.

D. membranacea Batt. (*Fucus membranaceus* Stackh., *F. polypodioides* Desfont., non Gmel., *Haliseris polypodioides*, C. A. Agardh).—Fronds tufted, 10–30 cm. high, 1–25 cm. wide, linear, several times dichotomous, traversed by conspicuous midrib; lamina rigid, thin, easily tearing from the margin to the midrib; margin entire and flat; clear olive-green, yellowish when young, becoming dark later; attachment organ disc-like, covered with matted fibres; tetrasporangia borne singly, sexual organs in sori. Odour strong and pungent when freshly gathered.

Rare; S. England, Channel Islands, and S. and W. of Ireland.

Order VII.—FUCALES

Large plants with apical growth and tissue formation. Sexual organs borne in conceptacles; no asexual reproduction. Haploid phase very short, the plants being diploid.

Family.—FUCACEÆ

Plants dioecious or hermaphrodite, reproductive organs in conceptacles lined with paraphyses and opening outwards by a narrow ostiole. Antheridia on branching filaments, antherozoids with two lateral cilia; oospores spherical, 1–8 in a mother cell; fronds usually dichotomously branched, rarely indefinitely expanded, often provided with air vesicles; cryptostomata frequent.

1. **FUCUS** Dene. & Thur.

(Gr. *phukos*, a seaweed.)

Fronds dioecious or hermaphrodite, attached by a disc, dichotomous; margin serrate or entire, often furnished with air vesicles; oospores spherical, 8 in each mother cell.

Key.

- | | |
|------------------------------------------------------|----------------------------|
| 1. Margin serrate | <i>F. serratus</i> (5). |
| Margin entire | 2. |
| 2. Plant diœcious | 3. |
| Plant monœcious | 4. |
| 3. Substance thin and transparent | <i>F. ceranoides</i> . (2) |
| Substance leathery | <i>F. vesiculosus</i> (4). |
| 4. Receptacle bearing narrow margin of the un- | |
| changed frond | <i>F. spiralis</i> (3). |
| Receptacle without such margin | 5. |
| 5. 5-10 cm. long, receptacle terminating in a barren | |
| point | <i>F. anceps</i> (1). |
| 30-60 cm. long, receptacle without barren apex ... | <i>F. ceranoides</i> (2). |

1. *F. anceps* Harv. & Ward. Lat. *anceps*, two headed.—Stipes short and cylindrical; frond 5-10 cm. long, repeatedly dichotomous, flat, with distinct mid-rib and a narrow web on either side in the older portions of the plant; younger branches nearly cylindrical, barren summits blunt, margin entire; air vesicles absent. Receptacles usually terminal in pairs, wider than the segments which support them, broadest at the base, terminating in a barren point.

In patches on ledges of the perpendicular side of rocks, together with *Gigartina mammillosa*.

2. *F. ceranoides* Linn.—Frond plane, 30-60 cm. long, membranous or leathery, linear-dichotomous, well-marked midrib, margin entire, air vesicles absent; thin and transparent, lateral branches narrower than the main branches, repeatedly forked, bearing receptacles at their apices. Receptacles bifid or spindle-shaped, acute, hermaphrodite or diœcious.

On rocks and stones between tide-marks, in places where fresh-water enters the sea, or land-locked bays. Not uncommon.

var. *Harveyanus* Kjellm.—Receptacles more elongated than the type. Elongated inflations sometimes present. Berwick and Cork.

var. *linearis* Batt. (*F. linearis* Huds., *F. distichus* Lightfoot, non Linn., *F. ceranoides* vars. *divergens* and *lacustris* Kjellm.).—Much narrower than the type. Very rare; Orkney Islands.

3. *F. spiralis* Linn. (*F. Areschougii* Kjellm.).—Frond broader than that of *F. vesiculosus*; margin entire, air vesicles absent; branching dichotomous, lateral branches frequently spirally twisted. Receptacles hermaphrodite, large, but not as swollen as in *F. vesiculosus*, and bearing a narrow margin of the unchanged frond; fruiting all the year.

On rocks near high-water mark. Not uncommon.

var. *nanus* Stackh. (*Halidrys nana* Stackh., *F. limitaneus* auct., *F. vesiculosus* Linn., var. *nanus* Batt.).—Gregarious, smaller than type. Rare; Northumberland.

4. *F. vesiculosus* Linn. Lat. *vesiculosus*, full of bladders.—Fronds dioecious, 15-90 cm. long, 0.6-2.5 cm. wide, stipitate,

midrib distinct throughout, margin entire, often wavy; air vesicles spherical or slightly elongated, usually in pairs on either side of the mid-rib, sometimes absent; receptacles swollen, ellipsoidal

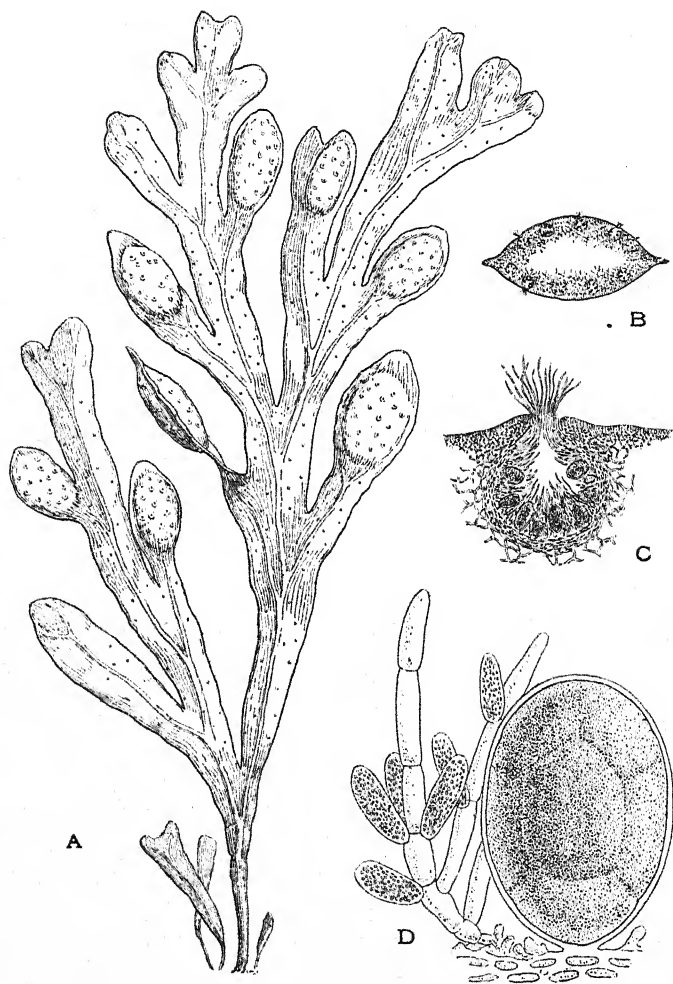


Fig. 138.—*Fucus spiralis* Linn. A. ($\times \frac{2}{3}$); B. Section through receptacle ($\times 2$); C. single conceptacle ($\times 30$); D. antheridia and oogonium ($\times 300$).

or oval, often forked. Fruiting all the year.

Very common on rocks and stones between tide-marks.

var. *divaricatus* Good. & Woodw.—Large vesicles borne in

the axils of divaricate branches. Probably not uncommon. Hants.

var. **angustifolius** Turn. (non *F. angustifolius* With.)—Fronde narrow, vesicles mostly wanting, receptacles sub-pedunculated, long, linear-lanceolate, acuminate. Rather rare; widely distributed.

var. **balticus** J. G. Agardh.—Very small, densely tufted, midrib indistinct without vesicles. Rare; widely distributed.

var. **laterifructus** Grev.—Common.

Bears a close resemblance to *F. ceranoides*, but is much thicker and more opaque, lateral branches densely dichotomously flabellate.

var. **sphærocarpus** J. G. Agardh.—Ultimate divisions of the frond repeatedly forked, bearing very numerous small receptacles. Not uncommon.

var. **vadorum** Aresch.—Numerous bladders. Rather rare; Devon.

var. **evesiculosus** Cotton.—Vesicles absent. Clare Island.

var. **muscoides** Cotton.—Forming dense mossy carpets. Clare Island.

5. **F. serratus** Linn. Lat. *serratus*, saw-like.—Fronde dioecious, 60–180 cm. long, midrib distinct throughout, margin serrate; air vesicles absent; receptacles pointed, flattened, serrate, either terminal or lateral. Fruiting in winter.

Very common on rocks from half-tide level to low-water mark.

var. **angustifrons** Stackh.—Much smaller and narrower than the type. Common.

var. **latifolius** Turn.—Upper branches widened upwards, of an ovate-lanceolate shape. Very rare; Bute and Orkneys.

var. **integer** Turn. (*F. angustifolius* With., *pro parte*).—Margins nearly entire. Very rare; South Coast.

var. **laciniatus** Grev.—Serrations narrow, cleft or lacinate. Very rare; Bute.

F. distichus Linn.—A doubtful British species; recorded as cast ashore at Port Seton (J. R. Henderson, 1882).

2. ASCOPHYLLUM Stackh.

(Gr. *askos*, a wine-skin, and *phyllon*, a leaf.)

Fronds linear, compressed, midrib absent, attached by a basal disc, branching irregularly dichotomous, air vesicles innate, simple. Receptacles shortly stalked, bright yellow when ripe, filled with mucus; oospores spherical, 4 in each mother cell.

Key.

Receptacles in the axils of marginal serrations, ovoid	<i>A. nodosum</i> .
Receptacles terminal or lateral on branchlets borne on the base of the branches, lanceolate, ovoid or forked	<i>A. Mackaii</i> .

A. nodosum Le Jol.—Fronds 30–150 cm. long, tough and leathery, compressed, irregularly dichotomous, margin serrate; air vesicles 2.5–5 cm. long, swollen, formed at intervals in

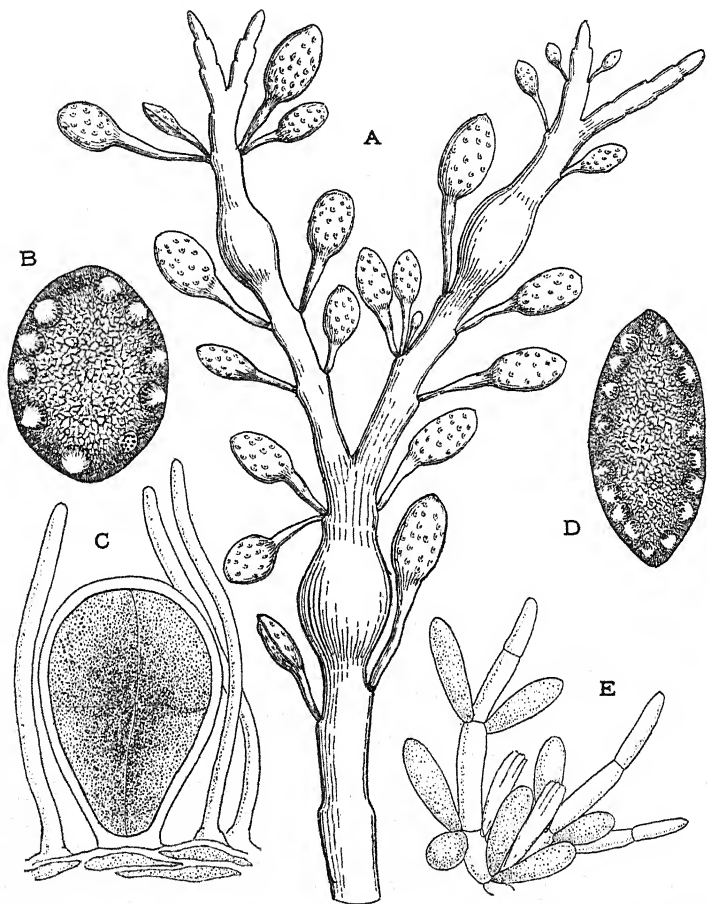


Fig. 139.—*Ascophyllum nodosum* Le Jol. A. portion of plant in fruit ($\times \frac{2}{3}$); B. Section through female receptacle ($\times 3$); C. single oogonium with paraphyses ($\times 300$); D. section through male receptacle ($\times 3$); E. group of antheridia ($\times 300$).

the main axis and branches, rarely absent. Receptacles ovoid or ellipsoid, solitary or in clusters, arising from the axils of the marginal serrations.

On rocks and boulders from high-water mark to half-tide level. Common and abundant on rocky shores.

var. **minor** Turn.—Receptacles ovoid, scarcely wider than the stipe. Rare; Hants.

var. **siliquatus** Turn.—Receptacles linear-lanceolate. Rare; Kent.

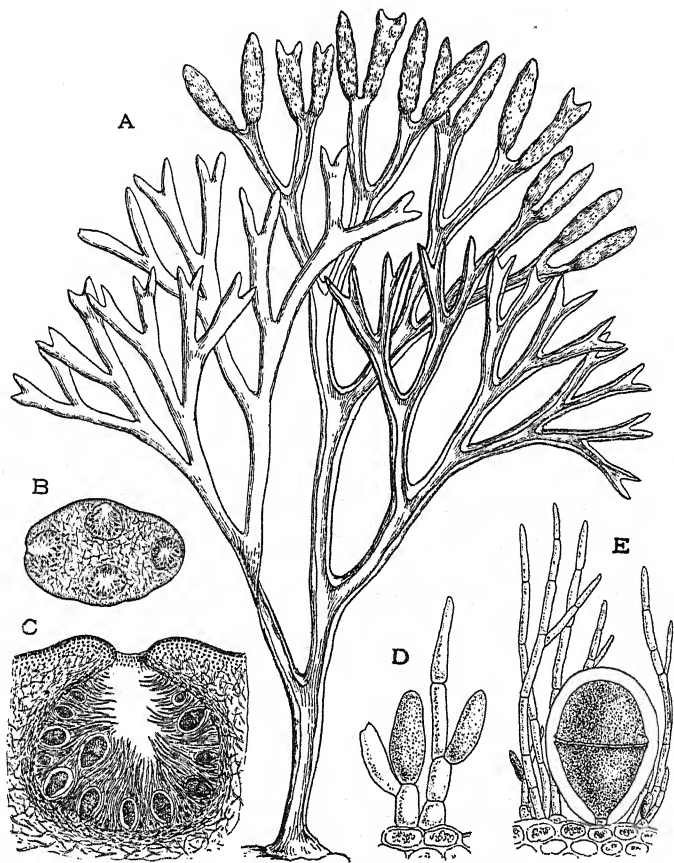


Fig. 140.—*Pelvetia canaliculata* Dene. & Thur. A. ($\times 1$); B. Section through receptacle ($\times 4$); C. Section through conceptacle ($\times 30$); D. antheridia ($\times 300$); oogonium with paraphyses and antheridia at the base ($\times 100$).

var. **scorpioides** Hauck.—Air vesicles absent. Rare; Essex and Galway.

A. Mackaii Holm. & Batt. (*Fucus Mackaii* Turn.).—Frond linear, flat, or cylindrical, irregularly dichotomously branched margin entire; air vesicles absent or occurring below the forkings of the longer branches; colour a dull olive; horny and

translucent when dry. Receptacles terminal or lateral, near the base of the branches, filled with mucus, dicecious or hermaphrodite, stalked, lanceolate, ovate or forked.

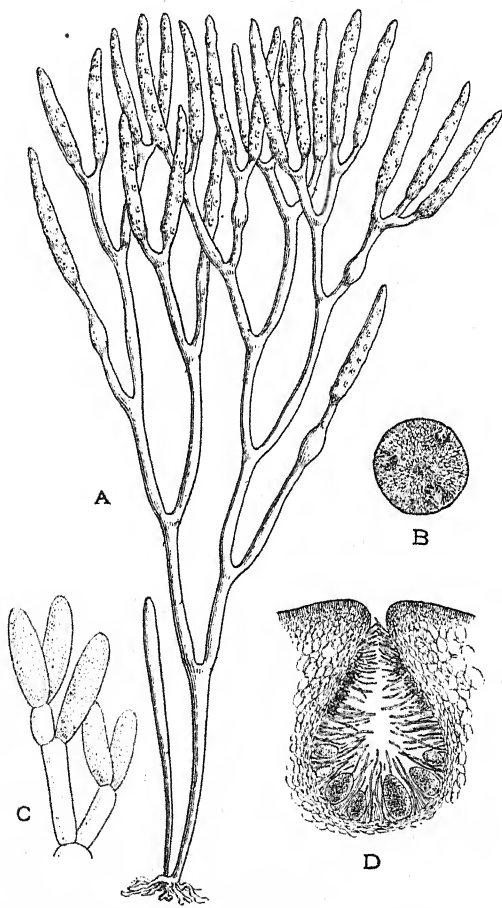


Fig. 141.—*Bifurcaria tuberculata*. A. ($\times \frac{1}{2}$); B. section through receptacle ($\times 4$); C. antheridia ($\times 330$); D. section through conceptacle, oögonia below, antheridia above ($\times 30$).

In globular tufts, 30 cm. or more in diameter, without apparent attachment, on muddy shores, usually in landlocked bays, among boulders. Very rare; Scotland and Ireland.

var. **Robertsoni** Batt.—Very rare; Arran.

3. PELVETIA Dene. & Thur.

(After Dr. Pelvet, French naturalist.)

Frond linear, compressed or cylindrical, irregularly dichotomously branched; air vesicles, when present, innate, simple. Receptacles terminal or lateral, 2 oospores in each mother cell.

P. canaliculata Dene. & Thur. (*Fucus canaliculatus* Linn.). Lat. *canaliculatus*, channelled.—Fronds tufted, 5–15 cm. long, deeply channelled on one side, rounded on the other, many times dichotomously branched, tough and leathery. Receptacles narrow-cuneate, deeply cloven or bipartite, containing numerous conceptacles, monœcious.

On rocky shores, between high-water mark and half-tide level, frequently in large quantities on the edge of high-water mark, often only moistened by the spray. Common and abundant on rocky shores.

4. BIFURCARIA Stackh.

(Lat. *bis*, twice, and *furca*, a fork.)

Attachment organ composed of branching fibres; frond cylindrical, dichotomous; air vesicles, when present, innate, simple. Receptacles elongated, terminal, simple.

B. tuberculata Stackh. (*Pycnophycus tuberculatus* Kütz.).—Attachment fibres extending in patches over the surface of the rock; fronds 30–50 cm. long, cylindrical, erect, simple near the base, then forked, irregularly dichotomous, one arm of the fork being larger than the other; clear olive in colour; tough, brittle when dry; axils obtuse, rounded, air vesicles often absent. Receptacles terminal, yellowish, bearing oogonial conceptacles below, antheridial conceptacles above.

S. England, Channel Islands, and N. and W. Ireland.

5. HIMANTHALIA Lyngb.

(Gr. *himas*, a thong, and *hals*, the sea.)

Frond top-shaped; receptacles very long, strap-shaped, repeatedly forked, arising from the centre of the frond, filled with mucus.

H. lorea Lyngb. Lat. *loreus*, made of thongs.—Fronds tufted, narrow obconical when young, gradually broadening above, finally becoming top-shaped with a concave upper surface; dark olive colour, coriaceous. Receptacles arising from the apex of the frond, from 5–25 cm. or longer, compressed, linear, repeatedly dichotomous, gradually attenuate at the apices. Plants dicecious, one oosphere in each mother cell.

Common on rocky shores, near low-water mark.

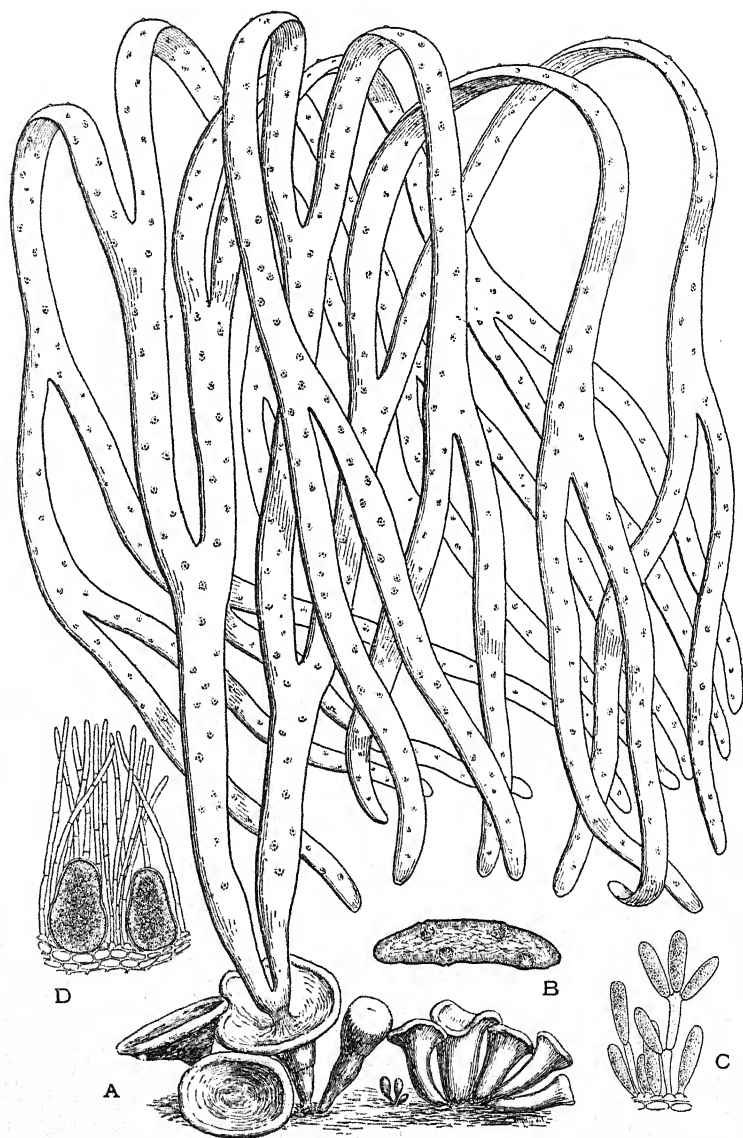


Fig. 142.—*Himantothalia lorea* Lyngb. A. ($\times \frac{1}{3}$); B. section through receptacle ($\times 2$); C. antheridia ($\times 80$); D. oogonia and paraphyses ($\times 180$).

6. HALIDRYS Lyngb.

(Gr. *hals*, the sea, and *drus*, an oak.)

Frond compressed, linear, pinnate, with distichous branches; air-vesicles lanceolate, stalked, jointed. Receptacles terminal, stalked, hermaphrodite.

H. siliquosa Lyngb.—Fronds 30–120 cm. long, linear, com-

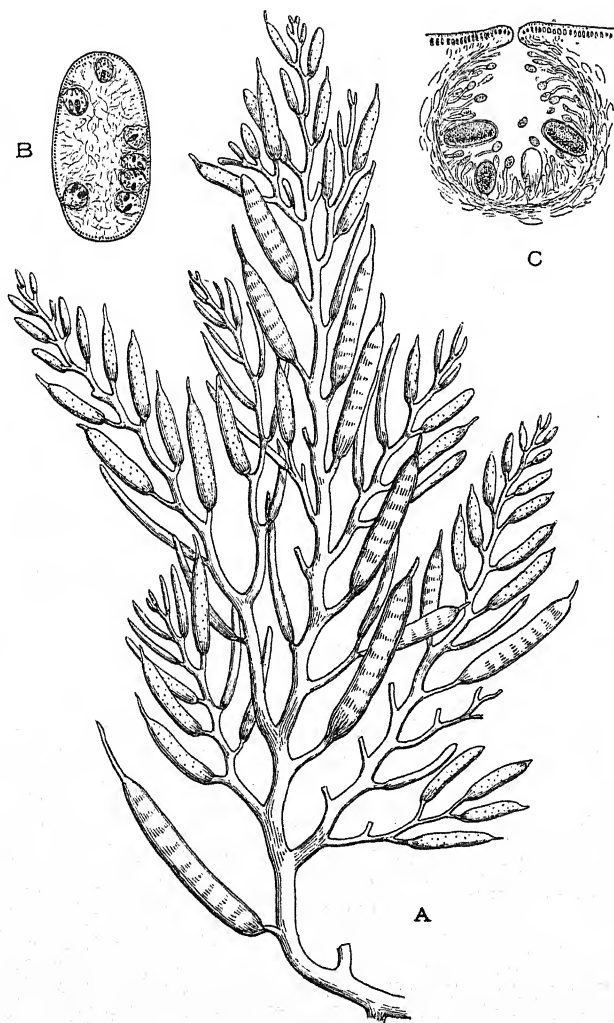


Fig. 143.—*Halidrys siliquosa* Lyngb. A. ($\times \frac{1}{3}$); B. Section through receptacle ($\times 6$); C. Section through conceptacle ($\times 40$).

pressed, two-edged, distichously pinnate or bi-pinnate; olive when young, becoming rich brown; very tough and leathery; pinnae alternate, naked or furnished with a few small branchlets and air-vesicles; air-vesicles linear, jointed, oblong or lanceolate, stalked, terminated by a small portion of undifferentiated frond, which itself may end in a receptacle. Receptacles forming racemes at the apices of the branches, bearing conceptacles which contain both antheridia and oogonia.

Common on rocky shores.

var. *siliculosus* (*F. siliculosus* Stackh., *H. siliquosa* var. *minor* Turn., and var. *gracilis* Holm. & Batt.)—Compressed, much branched, flexuose; fruit oblong, sharply pointed. Probably not uncommon; widely distributed.

7. CYSTOSEIRA C. A. Agardh

(Gr. *kustis*, a bladder, and *seira*, a chain.)

Thallus cylindrical or compressed, much branched; air-vesicles small, borne in the branches. Receptacles terminal on the ramuli, hermaphrodite, one oosphere in each egg cell.

Key.

- | | |
|----------------------------------------------------------------------------------|--------------------------|
| 1. Branches swollen at base | <i>C. granulata</i> (2). |
| Branches not swollen | 2. |
| 2. Plant iridescent under water | <i>C. ericoides</i> (1). |
| Plant not iridescent | 3. |
| 3. 30–60 cm. long; surface of branches rough, bearing spinous processes | <i>C. discors</i> (3). |
| 60–70 cm. long; surface of branches smooth, clothed with remains of ramuli | <i>C. fibrosa</i> (4). |

1. *C. ericoides* C. A. Agardh. *Erica*, a genus of flowering plants, Gr. *eidos*, like.—Usually solitary, 30–45 cm. long, with a cylindrical stem-like portion, simple or forked, divided ultimately into 4 or 5 main branches, each bearing numerous slender, crowded branchlets; iridescent when below the water, yellowish olive in the air; tough and leathery; branchlets alternate and distichous, densely set with short spine-like ramuli; air-vesicles few and small, oblong, usually borne on the terminal branchlets just below the base of the receptacles. Receptacles in the apices of the branches, oblong-cylindrical, becoming nodose, clothed with spine-like ramuli; antheridia tufted, oogonia obovoid.

On marine rocks, near low-water mark and in tide pools. Not uncommon; S. England, and S. and W. Ireland: very rare; Scotland.

2. *C. granulata* C. A. Agardh.—Much branched, lower stem-like portion cylindrical, 5–25 cm. long, bearing branches which have swollen elliptical bases; clear olive-green, darkening with age; leathery, horny when dry; branches filiform, slender, much

divided, alternately pinnate or dichotomous, smaller branches two or three times compound; air-vesicles innate in the branches, often below an axil and two or three together in the alternate branchlets; elliptic-oblong, axils obtuse; small, acute spine-

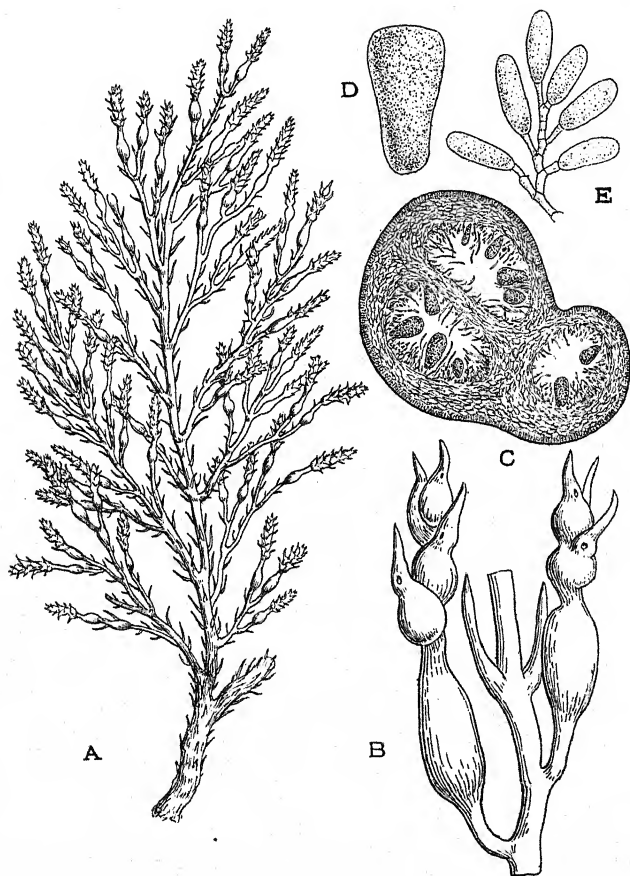


Fig. 144.—*Cystoseira ericoides* C. A. Agardh. A. ($\times \frac{3}{2}$); B. ($\times 6$); C. Section through receptacle ($\times 30$); D. oogonium ($\times 120$); E. antheridia ($\times 300$).

like ramuli scattered along the receptacles and branches. Receptacles lanceolate, irregularly nodose.

In rocky basins left by the tide, at and below half-tide level. Rather rare; S. England and S. and W. Ireland.

3. *C. discors* C. A. Agardh (*C. fœniculacea* Grev.). Lat. *discors*, disagreeing.—Much branched, 30–60 cm. long, stem-like portion 10–15 cm. long, rough in the upper part, with spine-like processes; branches numerous, lateral, alternate, 30–60 cm. long, filiform, rough, with spinous processes, especially below; older ones naked at the base, pinnate above; pale-olive colour in the branches, dark in the stem, coriaceous or cartilaginous; pinnæ two or three times divided, alternate or dichotomous, slender, containing small elliptical air-vesicles below their forkings; young branches sometimes leafy, bipinnate, pinnules furnished with mid-rib. Receptacles simple or divided, smooth, subtorulose, lanceolate, frequently subtended by air-vesicles.

On rocks, in tide-pools, near low-water mark. Rather rare; S. England and S. and W. Ireland.

4. *C. fibrosa* C. A. Agardh.—Mostly solitary; from 60–90 cm. long, very bushy, excessively branched; main axis simple or once or twice branched, with alternate, subdistichous slender branches with more or less numerous linear branchlets having a thin mid-rib and attenuate at each extremity; yellowish olive-green, becoming black in drying; woody below, coriaceous above. Branches somewhat compressed, gradually attenuate from the base to the apex, without any swelling at the base, more or less naked below and bearing remains of broken ramuli, closely pinnated above with alternate distichous branchlets which are themselves branched; air-vesicles elliptical, embedded in the ultimate branchlets. Receptacles terminating the lesser branchlets, clothed with setaceous ramuli when young.

On rocks near low-water mark and in tide pools; also in deeper water. Not uncommon; S. England and W. and S. Ireland.

RHODOPHYCEÆ

Key to Genera.

- | | |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1. No obvious protoplasmic continuity between the cells | 2. |
| Protoplasmic continuity between the cells | 10. |
| 2. Branched gelatinous sheath containing a single row of oval cells with blue-green star-shaped plastid and one pyrenoid | Asterocytis (p. 247). |
| Thallus red | 3. |
| 3. Forming pink patches on the inner surface of empty shells | Conchocelis (p. 249). |
| Occurring on other substrata | 4. |
| 4. Frond a flat adherent expansion on <i>Fuusta foliacea</i> | 5. |

- | | | |
|---------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------|
| Frond adhering by small attachment disc | 6. | |
| 5. Endozoic, irregular, creeping in the substance of the host | | Neevea (p. 248). |
| Creeping on the surface of the host ... | | Erythropeltis (p. 244). |
| 6. Frond flat, membranaceous | 7. | |
| Frond filiform | 8. | |
| 7. Frond at first saccate, later splitting and becoming monostromatic; gonidia formed from segmented portion of vegetative cell | | Porphyropsis (p. 244). |
| Frond flat, never saccate; gonidia formed from entire vegetative cell... | | Porphyra (p. 238). |
| 8. Thallus branched | | Goniotrichum (p. 245). |
| Thallus unbranched | 9. | |
| 9. Principally monosiphonous, bright red; gonidia formed from portion of vegetative cell | | Erythrotrichia (p. 241). |
| Principally polysiphonous, purplish; gonidia formed from whole of vegetative cell | | Bangia (p. 238). |
| 10. Thallus encrusted with lime (effervescing on treatment with dilute acid) | 11. | |
| Thallus not lime-encrusted | 16. | |
| 11. Thallus parasitic, forming wart-like conceptacles on <i>Corallina</i> | | Choreonema (p. 299). |
| Thallus not parasitic | 12. | |
| 12. Thallus articulate | | Corallina (p. 312). |
| Thallus not articulate | 13. | |
| 13. Attached by rhizoids; fructification not in conceptacles | | Peyssonnelia (p. 294). |
| No rhizoids; fructifications in conceptacles..... | 14. | |
| 14. Tetrasporic conceptacles with a single ostiole | 15. | |
| Tetrasporic conceptacles with more than one ostiole..... | | Lithothamnion (p. 307). |
| 15. Vegetative thallus consisting of hypothallium and perithallium | | Lithophyllum (p. 302). |
| Vegetative thallus usually monostromatic; if polystromatic without differentiation into hypo- and perithallium | | Melobesia (p. 300). |
| 16. Thallus expanded horizontally in a creeping or encrusting, continuous, membranous or gelatinous layer ... | 17. | |
| Thallus of another form | 29. | |
| 17. Vegetative thallus creeping in the cell-wall of the host | | Schmitziella (p. 298). |
| Occurring on rocks, stones, shells, or forming a superficial layer on the surface of other algæ | 18. | |
| 18. Thallus monostromatic or composed of very few layers of polygonal or rectangular cells, creeping on rocks | 19. | |
| Thallus of another form | 20. | |

19. Filaments forming the pseudo-parenchymatous layer arranged in dichotomous rows; tetraspores cruciate, in convex nemathecium; paraphyses absent Erythrodermis (p. 449).
 Filaments pinnately branched, tetraspores cruciate in the cells of the main axis Hymenoclonium (p. 390).
20. Erect filaments of vegetative thallus adherent to each other 21.
 Erect filaments only loosely coalescent at least in the upper parts 25.
21. Tetraspores in conceptacles sunk in the thallus Hildenbrandia (p. 296).
 Tetraspores not in conceptacles below the surface 22.
22. No paraphyses in tetrasporic nemathecium; thallus about 2.5 cm. in diam. Paraphyses present Porphyrodiscus (p. 444).
 23.
23. Tetraspores zonate Hæmatocelis (p. 445).
 Tetraspores cruciate 24.
24. Paraphyses separate, rigid, erect or curling over the tetrasporangia; rhizoids absent Rhododermis (p. 446).
 Paraphyses forming a continuous layer enclosing the tetrasporangia, rhizoids usually present Peyssonnelia (p. 294).
25. Tetrasporangia intercalary Petrocelis (p. 290).
 Tetrasporangia lateral or terminal 26.
26. Tetrasporangia lateral, zonately divided Cruoria (p. 291).
 Tetrasporangia lateral or terminal, not zonately divided 27.
27. No paraphyses in tetrasporic nemathecium Rhododiscus (p. 289).
 Paraphyses present 28.
28. Tetrasporangia immersed in the substance of the frond Cruoriopsis (p. 292).
 Tetrasporangia in convex nemathecium Cruoriella (p. 293).
29. Fringing the leaves of *Zostera* with dark red, hemispherical, globose or pear-shaped thalli, 100 μ to 1 mm. in diam. Rhodophysema (p. 448).
 Thallus of another form 30.
30. Thallus microscopic, consisting of rose-red, irregularly branched filaments, creeping entirely within the cell-walls of various algae Colaconema (p. 250).
 Thallus of another form 31.
31. Minute parasites, each usually limited to one host 32.
 Not parasitic 40.
32. Consisting of a group of leafy fronds, arising from wart-like prominences, on *Nitophyllum* Gonimophyllum (p. 326).
 Thallus filiform or pustular 33.
33. Thallus filiform, articulate, monosiphonous; asexual reproduction by monospores Acrochætium (p. 251).
 External thallus forming a pustule on the surface of the host 34.

34. Forming an irregularly lobed swelling on *Ahnfeltia* or *Callophyllis* 35.
 Forming a sub-hemispherical cushion on host 36.
35. On *Ahnfeltia*; monospores produced in outermost cells Sterrocolax (p. 414).
 On *Callophyllis*; tetrasporangia cruciately divided Callocolax (p. 416).
36. Pustule consisting mainly of seriate tetraspores 37.
 Pustule consisting of branched filaments united into a parenchymatous mass, bearing cystocarps or marginal tetraspores 38.
37. Vegetative thallus endophytic, filaments ramifying in the tissues of the host Actinococcus (p. 413).
 Superficial haustoria penetrating the host Colacolepis (p. 414).
38. Cells of the pustule arranged in fairly distinct rows Choreocolax (p. 423).
 Cells arranged as sub-dichotomously branched filaments 39.
39. Parasitic on *Rhodomela subfusca* Harveyella (p. 426).
 Parasitic on *Gracilaria confervoides* ... Holmsella (p. 426).
40. Thallus filamentous or cylindrical, compressed, or constricted at intervals 41.
 Thallus membranaceous 115.
41. Thallus tubular, with or without diaphragms at the nodes 42.
 Thallus not tubular 46.
42. Thallus brownish purple, without nodal constrictions Dumontia (p. 274).
 Thallus constricted at intervals 43.
43. Forming tufts, 1-3 cm. high, purple or nearly black; tetraspores zonate ... Catenella (p. 418).
 Not tufted 44.
44. Tetraspores in small cortical cavities ... Lomentaria (p. 437).
 Tetraspores scattered 45.
45. Cystocarp conical with apical ostiole ... Champia (p. 439).
 Cystocarp spherical, ostiole not conspicuous Chylocladia (p. 441).
46. Monosiphonous axis, visible at least in the younger parts, without pericentral siphons 47.
 Monosiphonous axis with a ring of pericentral siphons, or having the centre occupied by a central core of small cells 93.
47. Filaments ecorticate throughout 48.
 Filaments partly or completely corticate 64
48. Forming dense tufts, 2-4.5 cm. high; tetraspores irregularly cruciate, immersed in the thallus Trailliella (p. 364).
 Tetrasporangia lateral or terminal 49.
49. Sporangia usually undivided 50.
 Sporangia 4- or multi-partite 51.

* Recent work has shown that these plants are not external parasites, but represent one stage in the life-history of their so-called hosts.

50. Thallus forming small epiphytic tufts, rarely 1 cm. high, sporangia always undivided *Acrochaetium* (p. 251).
 Thallus few to many cm. high, tetrahedral tetraspores usually replaced by monospores *Monospora* (p. 371).
51. Sporangium many times divided, usually more than 4 spores to a sporangium *Pleonosporium* (p. 373).
 Four spores in each sporangium 52.
52. Bearing whorls of more than 4 ramuli at the nodes 53.
 Branching of another form 56.
53. Densely tufted, 2.5-5 cm. long, epiphytic on smaller algae *Crouania* (p. 392).
 Thallus 7-25 cm. long, growing on rocks 54.
54. Gelatinous; tetraspores zonate *Dudresnaya* (p. 276).
 Crisp or cartilaginous; tetraspores tetrahedral 55.
55. Whorls of ramuli closely set, incurved, covering the main axis *Halurus* (p. 370).
 Ramuli incurved, shorter than the articulations which remain bare between the whorls *Sphondylothamnion* (p. 360).
56. Tetrasporangia cruciately divided 57.
 Tetrasporangia tetrahedrally divided... 58.
57. Branching alternate or dichotomous ... *Rhodochorton* (p. 374).
 Two or four ramuli arising at each node *Antithamnion* (p. 388).
58. Tetraspores usually terminal on the ramuli 59.
 Tetraspores lateral 60.
59. Thallus minute, about 2 cm. long, forming velvety patches usually on the stipes of *Laminaria* *Ptilothamnion* (p. 365).
 Thallus 2.5-10 cm. long, on rocks near low-water mark *Compsothamnion* (p. 384).
60. Two to four ramuli at each node, crowded towards the extremities ... *Antithamnionella* (p. 390).
 Vegetative ramuli not whorled at the nodes 61.
61. Tetraspores borne at the nodes on the inner side of whorled, incurved, re-productive ramuli 62.
 Tetraspores not borne on whorled ramuli 63.
62. Cystocarp in gelatinous envelope *Griffithsia* (p. 366).
 Gelatinous envelope absent *Bornetia* (p. 370).
63. Cystocarp usually 2 lobed, in gelatinous envelope *Callithamnion* (p. 376).
 Cystocarp naked *Spermothamnion* (p. 361).
64. Cortication restricted to the nodes, at least in the branches of the second order 65.
 Cortication not restricted to the nodes 66.
65. Branching dichotomous; tetraspores in the cortical cells *Ceramium* (p. 395).
 Branching irregular; tetraspores lateral on the ramuli *Spyridia* (p. 393).

66. Cortication covering the whole thallus 72.
 Cortication not complete 67.
67. Whorls of monosiphonous moniliform
 filaments at right angles to the sur-
 face of the axis 68.
 Thallus without lateral whorls 69.
68. Cells of the moniliform filaments cla-
 vate, elongated Dudresnaya (p. 276).
 Cells of the moniliform filaments
 scarcely longer than broad Atractophora (p. 267).
69. Consisting of a central siphon, sur-
 rounded by a band of loosely
 arranged hyaline cells, bounded by a
 zone of small assimilating cells Naccaria (p. 269).
 Thallus of another form 70.
70. Cystocarp with involucreal ramuli,
 thallus many times pinnated with
 short opposite ramuli Plumaria (p. 385).
 Cystocarp without involucreal ramuli ... 71.
71. Cells uninucleate; gonimoblast consist-
 ing of branched clusters of sporo-
 genous filaments Seirospora (p. 382).
 Cells multinucleate; rounded, many-
 celled gonimolobes spring from a
 small central cell in the cystocarp ... Callithamnion (p. 376).
 Apices forcipate Ceramium (p. 395).
 Apices not forcipate 73.
73. Thallus markedly compressed at least
 in the upper parts..... 74.
 Thallus terete 83.
74. Thallus fan-shaped, ending in acute
 branchlets, the whole fringed with
 short proliferations Sphærococcus (p. 428).
 Thallus not fan-shaped 75.
75. Rose-red, not markedly cartilaginous... 76.
 Dark in colour, cartilaginous 77.
76. Ramuli alternate Bonnemaisonia (p. 269).
 Ramuli alternately secund Plocamium (p. 443).
77. Branching pinnate 80.
 Branching alternate or irregularly di-
 chotomous 78.
78. Apices of the ramuli obtuse Laurencia (p. 338).
 Apices of the ramuli acute 79.
79. Cystocarps sub-globose surrounded by
 involucreal ramuli Microcladia (p. 403).
 Cystocarps spherical, immersed in the
 thallus..... Pantoneura (p. 318).
80. Apices of the ramuli obtuse Laurencia (p. 338).
 Apices of the ramuli acute 81.
81. Cortication of one or two rows of small
 polygonal cells Ptilota (p. 388).
 Cortication of radially elongated, di-
 chotomous rows of cells, becoming
 smaller towards the periphery 82.
82. Cystocarp with one ostiole Pterocladia (p. 265).
 Cystocarp with 2 ostioles, one on each
 side of the frond Gelidium (p. 262).
83. Apices of the branches curled 84.
 Apices not curled 85.

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 84. Plants crimson | Bonnemaisonia p. 269). |
| Plants dark purple | Bostrychia (p. 332). |
| 85. Apices of the ramuli obtuse | Laurencia (p. 338). |
| Apices of the ramuli acute | 86. |
| 86. Branching distichous..... | 87. |
| Branching not distichous | 89. |
| 87. Thallus crimson, clothed with short,
alternate ramuli | Bonnemaisonia (p. 269). |
| Dark in colour, ramuli pinnate or absent | 88. |
| 88. Branches fringed throughout with short
pinnate ramuli | Ptilota (p. 388). |
| Branches without short ramuli | Dumontia (p. 274). |
| 89. Cortication of short, radial, dichotomous
rows of cells | 90. |
| Cortication a zone of large cells with a
peripheral zone of smaller assimila-
ting cells | Rhodomela (p. 335). |
| 90. Each siphon bearing a cruciate whorl of
cells, from which dichotomous rows
of cells extend to the periphery | Calosiphonia (p. 280). |
| Thallus of another structure | 91. |
| 91. Thallus branched but devoid of ramuli | Dumontia (p. 274). |
| Thallus clothed with ramuli..... | 92. |
| 92. Corticating filaments closely set, their
apices forming a continuous surface | Gloiosiphonia (p. 272). |
| Corticating filaments not forming a con-
tinuous surface | Naccaria (p. 269). |
| 93. Axis of one central and 2 or more peri-
central siphons, with or without
cortication | 95. |
| Axis of a core of small cells, with corti-
cation of various form | 94. |
| 94. Gelatinous, periphery of the thallus
formed of short, corymbose branches
of cells, elongated radially, forming a
pseudo-cortex | 103. |
| Coriaceous, thallus parenchymatous
throughout | 108. |
| 95. Ramuli wholly or in part mono-
siphonous | 96. |
| Ramuli polysiphonous | 100. |
| 96. Apices of branches spirally coiled | Bostrychia (p. 332). |
| Apices not spirally coiled | 97. |
| 97. Cystocarps small, oval, attached to the
base of the ramuli | Dudresnaya (p. 276). |
| Cystocarps urn-shaped, lateral on
branches or ramuli | 98. |
| 98. Tetraspores in the articulations of the
branches | Brongniartella (p. 335). |
| Tetraspores in special stichidia | 99. |
| 99. Tetraspores not covered by outer-cells
of stichidia | Dasya (p. 356). |
| Tetraspores covered by outer-cells | Heterosiphonia (p. 358). |
| 100. Branches and ramuli recurved near
their apices, branches pectinate with
a double set of subulate ramuli on
their upper side | Halopitys (p. 340). |
| Thallus of another form | 101. |

101. Ramuli fusiform or claviform; tetrasporangia scattered in the ramuli, cortication complete over the whole thallus..... Chondria (p. 342).
 Ramuli usually subulate; tetrasporangia borne longitudinally or spirally in the ramuli; articulations usually visible 102.
102. Attachment organ formed by stunted lateral ramuli of procumbent branches developing numerous rhizoids and frequently actually encircling the host Pterosiphonia (p. 352).
 Attachment organs various but never formed from stunted lateral branches Polysiphonia (p. 344).
103. Thallus compressed 107.
 Thallus terete 104.
104. Inner axis sharply delimited, bearing the assimilating filaments which form the pseudo-cortex Helminthora (p. 259).
 Inner axis not sharply delimited from the peripheral pseudo-cortex 105.
105. Terminal cells of pseudo-cortex not larger than inner cells Nemalion (p. 256).
 Moniliform assimilating filaments ending in large cells 106.
106. Assimilating filaments separate but surrounded by jelly Helminthocladia (p. 257).
 Assimilating filaments united into a pseudoparenchyma Scinaia (p. 260).
107. Thallus often proliferous from the margin, corymbose branches united to form a pseudoparenchyma Grateloupia (p. 272).
 Thallus not proliferous from the margin, corymbose branches united only by jelly Platoma (p. 281).
108. Thallus more than 0.5 mm. in diam. in the greater part of the frond 109.
 Thallus 0.5 mm. or less in diam., dark, wiry 114.
109. Branching regularly dichotomous 110.
 Branching irregularly dichotomous or alternate 112.
110. Centre of thallus occupied by large cells, becoming progressively smaller towards the exterior Cordylecladia (p. 437).
 Centre of thallus occupied by small cells 111.
111. Attached by a disc; tetraspores cruciate Polyides (p. 287).
 Attached by creeping rhizoids, tetraspores zonate Furcellaria (p. 286).
112. Centre of thallus occupied by large cells, polygonal in transverse section 113.
 Centre of thallus occupied by longitudinally elongated cells, small in transverse section Cystoclonium (p. 418).
113. Filaments 4-6 cm. long; tetraspores zonate, in siliculate ramuli Cordylecladia (p. 437).
 Filaments more than 6 cm. long; tetraspores cruciate, in scarcely swollen ramuli Gracilaria (p. 429)

114. In tufts, 2-5 cm. high, main branches
all of the same length, regularly di-
chotomous Gymnogongrus (p. 412).
Thallus 1-15 cm. high, in tangled tufts,
branches very variable in length,
arising irregularly Ahnfeltia (p. 414).
115. Fronds with definite mid-rib 116.
Mid-rib indefinite or none 122.
116. Frond dark brownish purple, narrow,
dentate Odonthalia (p. 336).
Frond fan-shaped or leaf-like 117.
117. Frond expanded into a fan-shaped
membrane, dichotomously divided,
bright clear red; cystocarps borne
in the mid-rib Stenogramma (p. 410).
Frond leaf-like 118.
118. Pinnate lateral veins visible to the naked
eye, arising from the main vein 119.
No lateral veins visible to the naked
eye 120.
119. Frond with lanceolate leaf-like struc-
tures, margins entire Delesseria (p. 315).
Frond with oval, elongated leaf-like
structures, margins lobed Phycodrys (p. 327).
120. Microscopic lateral veins absent Hypoglossum (p. 320).
Microscopic lateral veins present 121.
121. Frond repeatedly proliferous from the
mid-rib, linear-oblong Apoglossum (p. 319).
Frond rarely proliferous from the mid-
rib, linear Membranoptera (p. 317).
122. Thallus formed of a single mono- or
polystromatic layer of cells without
internal tissue differentiation 123.
Thallus formed of an upper and lower
layer of cells divided by zone of
anastomosing filaments or of cells
differing in size and shape from the
limiting layers 129.
123. Microscopic veins absent 124.
Microscopic veins present 126.
124. Carpospores in chains Myriogramme (p. 322).
Carpospores not in chains 125.
125. Tetrasporang. scattered in the thallus
Tetrasporang. in marginal sori Nitophyllum (p. 321).
126. Tetrasporang. scattered in the thallus
Tetrasporang. in sori Erythroglossum (p. 329).
Polyneura (p. 330).
127. Tetrasporang. in marginal sori or in
marginal proliferations 127.
Tetrasporang. in sori below the apices
Cryptopleura (p. 332).
128. Apical cell elongated at right angles to
the periphery of the thallus 128.
Apical cell elongated parallel to the
periphery of the thallus Acrosorium (p. 323).
129. Frond dark brownish purple, narrow,
dentate Rhizoglossum (p. 326).
Frond of another form Odonthalia (p. 336).
130. Internal layers entirely filamentous 130.
Internal layers parenchymatous, some-
times traversed by a few filamentous
rows of cells 131.
138.

131. Thallus entire, much lobed, or broken up, but unbranched 132.
 Thallus branched 134.
132. Thallus thick, solid, gradually attenuate at the base into a stipe, when dry having the consistency of thin cardboard *Dilsea* (p. 278).
 Thallus more or less gelatinous, gradually or sharply attenuate at the base, when dry having the consistency of paper 133.
133. Peripheral layers a band of small cells arranged in corymbose rows, perpendicular to the surface *Schizymenia* (p. 281).
 Peripheral layers a few rows of small cells without corymbose arrangement *Halymenia* (p. 274).
134. Thallus soft, gelatinous, centre sparsely traversed by anastomosing filaments 135.
 Thallus of another structure 136.
135. Peripheral layer consisting of anticlinal rows of cells, becoming progressively smaller towards the exterior *Platoma* (p. 281).
 Peripheral layer a few rows of small compact cells *Halarachnion* (p. 284).
136. Thallus purplish red or iridescent, membranous above, attenuate below into a branched terete stipe 137.
 Thallus blood-red, membranous, sharply attenuate into a short stipe *Callymenia* (p. 416).
137. Adult thallus dark purplish red, clothed with short proliferations *Gigartina* (p. 406).
 Adult thallus iridescent in the water, plane or slightly channelled, variously expanded but without short proliferations *Chondrus* (p. 404).
138. Thallus branched, margins fringed with dentate proliferations, attached by branched rhizoids *Calliblepharis* (p. 431).
 Thallus without dentate fringed margins; usually attached by a disc ... 139.
139. Thallus thin and delicate; tetraspores regularly zonate *Rhodophyllis* (p. 422).
 Thallus membranaceous, but firm 140.
140. Frond narrow, much divided, upper divisions divaricately toothed *Euthora* (p. 421).
 Frond of another form 141.
141. Thallus with thickened undulate border, more or less palmate; when in fruit, margin fringed with minute cystocarpic proliferations *Callophyllis* (p. 414).
 Thallus without undulate border 142.
142. Thallus cartilaginous, dense; cystocarps external, globose *Phyllophora* (p. 408).
 Thallus coriaceous; cystocarps hemispherical *Rhodymenia* (p. 433).

Subclass I.—PROTOFLORIDEÆ

Protoplasmic continuity not obvious between the cells.

Order.—BANGIALES

Cells forming the thallus isolated or united into filamentous or membranous colonies, of one or two cell-layers; cells usually similar in form, with intercalary growth, obvious protoplasmic continuity never established; red, violet, yellowish or occasionally bluish green; plastids usually stellate. Vegetative reproduction by cell-division in unicellular forms, by fragmentation in multicellular forms; asexual reproduction by non-motile gonidia, produced in an undivided vegetative cell or in a portion cut off by a curved wall; sexual reproduction by spermatia and carpogonia, formed in the cells of the thallus; monœcious or dioecious, fertilisation resulting in the production of carpospores.

Family.—BANGIACEÆ

Tribe 1. *BANGIÆÆ*.—Gonidia arising directly from the whole of an originally vegetative cell, or from a part of it.

1. *BANGIA* Lyngb.

(After N. H. Bang, Danish botanist.)

Fronds gelatinous, simple, filiform, unbranched, cylindrical, densely tufted, composed at first of a single row of cells, later becoming several cells thick. Reproduction by asexual gonidia and by spermatia and carpogonia.

B. fusco-purpurea Lyngb. Lat. *fuscus*, dark, *purpureus*, purple.—Plant at first a filament consisting of a single cell-row, later longitudinally divided into a number of wedge-shaped cells. Filaments blackish purple, 5–15 cm. long, clustered in dense lubricous masses. Spermatia and carpogonia on different plants.

Covering rocks and woodwork with dense gelatinous fleece. Not uncommon; widely distributed.

var. *crispa* Holm. & Batt. Articulations swollen in adult form, cells in groups of 4, arranged in longitudinal series at the apex. Rare; Cornwall, Dorset and Norfolk.

var. *Lejolisii* Holm. & Batt.—Gonidia mauve; frond markedly thicker than in the type. Rare; Devon.

2. *PORPHYRA* C. A. Agardh

(Gr. *porphura*, a purple dye.)

Fronds membranaceous, gelatinous, consisting of a single layer of cells (two layers in the subgenus *Diploderma*) those near

the base growing downwards to form an attachment disc. Asexual reproduction by gonidia; sexual reproduction by carpogonia and spermatia; monœcious or diœcious.

Key.

- | | |
|---------------------------------------------------|----------------------------|
| 1. Frond monostromatic | 2. |
| Frond of two cell-layers | <i>P. miniata</i> (4). |
| 2. Frond rigid, amethyst | <i>P. amethystea</i> (3). |
| Frond soft, reddish | 3. |
| 3. Spermatia formed in longitudinal patches..... | <i>P. leucosticta</i> (1). |
| Spermatia formed in the margin of the frond | <i>P. umbilicalis</i> (2). |

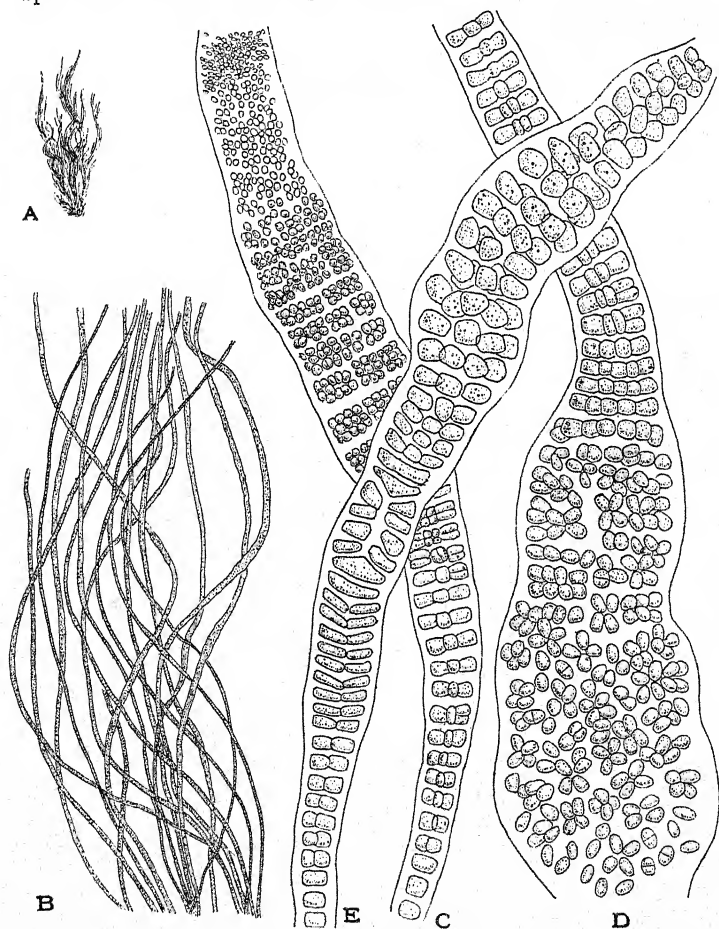


Fig. 145.—*Bangia fusco-purpurea* Lyngb. A. Plant ($\times \frac{1}{2}$); B. Filaments ($\times 40$); C. Filament with spermatia ($\times 300$); D. Filament with carpogones ($\times 300$); E. Filament with gonidia ($\times 300$).

Subgenus 1.—*Euporphyra* Rosenv.—Thallus monostromatic.

1. *P. leucosticta* Thur. Gr. *leukostiktos*, grizzled.—Thallus purplish red, very shortly stalked, attached by a minute disc, usually entire, rarely a little lobed, the margin more or less undulated; length 10–40 cm.; longest fronds lingulate, 2–4 cm. broad, with rounded or cordate base, sometimes with margins overlapping, forming an umbilicate attachment. Spermatia in longitudinal patches, 5–10 mm. by 1–1.5 mm. in the upper part of the frond; isolated cystoc. have been observed scattered among the antheridia; carpog. elongated, sometimes papillate above and below, each with 8 carpospores.

On stones and the larger algæ. Common in spring and early summer.

2. *P. umbilicalis* J. G. Agardh.—Fronds purplish red 5–20 cm. long, clustered together, expanded, delicately membranaceous,

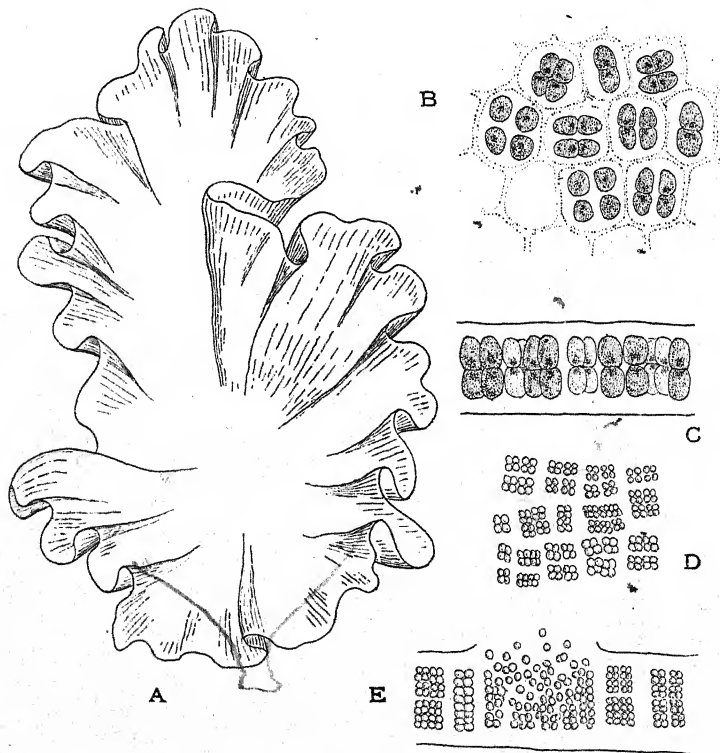


Fig. 146.—*Porphyra umbilicalis* J. G. Agardh. A. Plant ($\times \frac{1}{2}$); B. Surface of thallus showing carpospores ($\times 300$); C. T.S. with carpospores ($\times 300$); D. Surface view showing spermatia ($\times 300$); E. The same in T.S. ($\times 300$).

irregularly divided into several lobes, the point of attachment frequently within the frond, which is then umbilicate; margin wavy, entire or irregularly dentate, apices often truncate. Plants monœcious or diœcious; reproductive organs similar to those of *P. leucosticta* but occupying a marginal zone on the frond.

Common and abundant everywhere on the rocky parts of the coast.

var. **vulgaris** C. A. Agardh.—Fronds 30–60 cm. long, as much as 7.5 cm. broad, simple, lanceolate or linear, much attenuate at the apex, at first ovate at the base, later cordate, margin flat and even or wavy. Not uncommon; widely distributed.

Distinguished from the species by being simple and not irregularly cloven, and by the much greater length of the frond in proportion to its breadth. *P. linearis* Harv. is a narrow growth form.

3. ***P. amethystea*** Kütz.—Frond amethyst, obovate, shortly stipitate, rigid, cartilaginous; cells elongated perpendicularly.

Very rare; Yorkshire, Joppa, Fife, Forfar and Ireland.

Subgenus 2.—***Diploderma*** Rosenv. Thallus composed of 2 cell-layers.

4. ***P. miniata*** C. A. Agardh. Lat. *miniatus*, cinnabar-red.—Fronds deep red, 15–30 cm. broad, of two layers of large sub-quadrangle cells.

Locally abundant in spring and early summer; Northumberland, Bute, Orkneys and Ireland.

var. **amplissima** Rosenv. (*Diploderma amplissimum* Kjellm).—Darker in colour than the type, with greater thickness and deep folds. Very rare; Bute and Ireland.

var. **tenuissima** Rosenv. (*D. tenuissimum* Strömf).—Thallus 25–36 μ thick; cells horizontally rectangular. Very rare; Bute.

var. **abyssicola** Rosenv. (*Porphyra abyssicola* Kjellm).—Much less folded than the type. Locally abundant; Bute and the Orkneys.

Tribe 2. **ERYTHROTRICHIEÆ**.—Gonidia in special gonidia cut off by a curved wall in a vegetative cell.

3. **ERYTHROTRICHIA** Aresch.

(Gr. *eruthros*, red, and *trichion*, a small hair.)

Fronds rose-coloured, simple, filamentous, usually a single row of cells. Spermatia and carpogonia formed in a portion of a vegetative cell, cut off by a curved wall; asexual reproduction by gonidia-formation in a vegetative cell, the single gonidium being isolated from the mother-cell by an oblique wall.

Key.

- | | |
|----------------------------------------------------------------------------------------------------|----------------------------|
| 1. Possessing a discoid primary thallus from which erect filaments arise | 2. |
| No discoid primary thallus | 4. |
| 2. Frond tubular | <i>E. ciliaris</i> (2). |
| Frond monostromatic | 3. |
| 3. Filaments monosiphonous at the base, sometimes containing two cell rows in the upper part | <i>E. investiens</i> (4). |
| Filaments monosiphonous below, broadening into a flattened thallus above | <i>E. Boryana</i> (5). |
| 4. Filaments simple | 5. |
| Filaments branched | 6. |
| 5. Frond monosiphonous | <i>E. carnea</i> (1). |
| Frond polysiphonous | <i>E. Bertholdii</i> (3). |
| 6. Filaments attenuate at the base | <i>E. Welwitschii</i> (7). |
| Filaments attenuate at both ends | <i>E. reflexa</i> (6). |

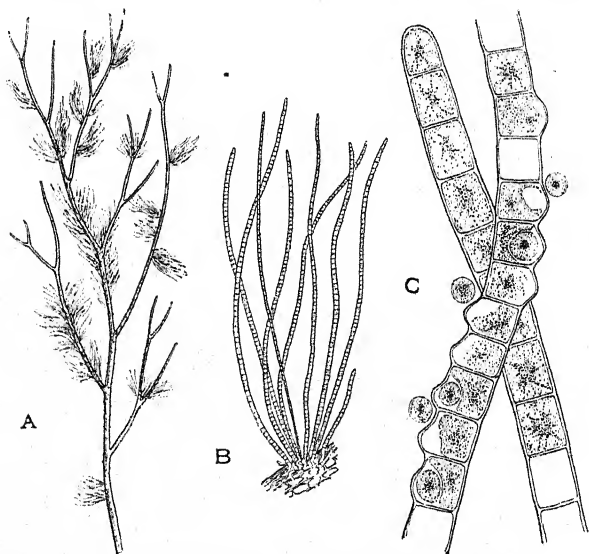


Fig. 147.—*Erythrotrichia carnea* J. G. Agardh. A. On *Spermatocnus* ($\times \frac{3}{8}$); B. Group of filaments ($\times 60$); C. Filaments with gonidia ($\times 600$).

1. *E. carnea* J. G. Agardh (*Bangia ceramicola* Chauv.).—Filaments delicately membranous, 2.5 to 4 cm. long, $12-24\mu$ thick; attached at the base by a basal cell giving off short rhizoids radiating in all directions; cells either as long as broad, or more commonly twice their breadth, slightly barrel-shaped, containing a star-shaped plastid with numerous narrow branches. Sexual reproduction unknown; asexual reproduction by gonidia in vegetative cells, each gonidium being isolated by an oblique wall from the mother-cell.

Epiphytic on various algæ in tide pools. Rarely met with in quantity; isolated filaments common.

2. *E. ciliaris* Batt. (*Bangia ciliaris* Carm.).—Filaments gregarious, forming a reddish purple fringe on the leaves of *Zostera* or on the fronds of other algæ, 1–10 mm. long, erect, straight or slightly curved, formed of one, two or more rows of cells; cells 9–10 μ in diam.; frond tubular. Attached by monostromatic disc.

Very rare; Cornwall, Argyle and Forfar.

3. *E. Bertholdii* Batt. After G. Berthold, German botanist.—Filaments cylindrical, slender below, gradually broadening from 10–12 μ at the base to 60–70 μ in the widest part; each filament attached by slightly expanded basal cell; trans. sect. of upper portion of frond shows 4–8 cells radially arranged.

On the leaves of *Zostera*. Very rare; widely distributed.

4. *E. investiens* Born.—Filaments 8–12 μ broad at the base, 25–30 μ above, basal portion always monosiphonous, upper portion sometimes with 2 cell-rows which distinguish it from *E. carnea* J. Ag.

Occurring in groups, basal cells forming disc. Very rare; widely distributed

5. *E. Boryana* Berth. (*Porphyra ciliaris* Crouan). After Bory de St. Vincent, French naturalist.—Forming tufts, 3–10 mm. in height; thallus very delicate, linear, 40–400 μ broad, simple, much attenuate at the base; consisting at first of one cell-row, the cells being 9–12 μ in diam.; later two or more cell-rows are formed by cell-division. Easily distinguished from *E. ciliaris* Batters. by its monostromatic frond.

Very rare; Cornwall, Devon, Sussex and Kent.

var. *crispa* Batt.—Margins crenate, more or less crisped and curled. Very rare; Scilly Islands.

6. *E. reflexa* Thur. (*Bangia reflexa* Crouan).—Forming violet tufts 1–4 mm. high, filaments 10–50 μ thick, generally curved at intervals, simple or sometimes branched at the base, formed of one or more rows of cells, or becoming almost parenchymatous in the middle portion; cells 10–20 μ in diam., half as long as broad or equal in length and breadth.

Epiphytic on other algæ. Very rare; Dorset.

7. *E. Welwitschii* Batt. (*Cruoria Welwitschii* Rupr., *Callithamnion lepadicola* J. G. Agardh). After F. Welwitsch, German botanist.—Plant attached by basal rhizoid; filament simple below, abundantly branched above; branches unilateral, several arising from the same point on the thallus; main filaments 10–12 μ broad below, 35–40 μ above; monosiphonous at the base, sometimes polysiphonous in the upper portions.

Parasitic on *Ralfsia* growing on shells of *Patella*. Very rare; Dorset and the Channel Islands.

4. **PORPHYROPSIS** Rosenv.

(*Porphyra*, a genus of algæ, and Gr. *opsis*, appearance.)

Plant when young a parenchymatous cushion becoming globular and vesicular, which later, by splitting, forms a leafy frond. Gonidia formation as in *Erythrotrichia*, sexual reproduction unknown.

P. coccinea Rosenv. Lat. *coccineus*, scarlet.—Fronds bright red, delicate and easily torn, 0.6–3.75 cm. in diam.; attached by

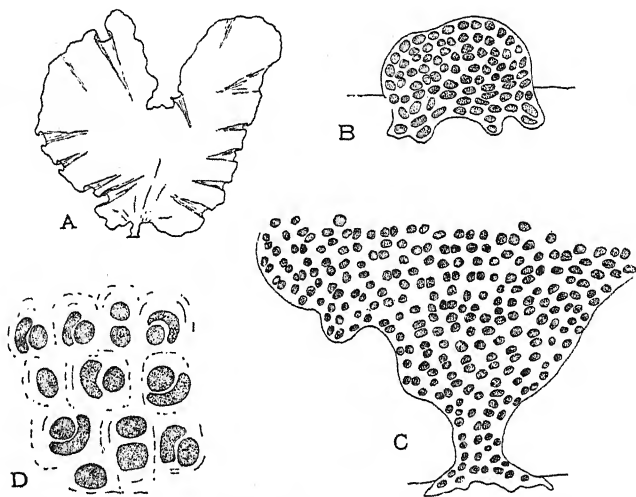


Fig. 148.—*Porphyropsis coccinea* Rosenv. A. ($\times 200$); B. Young plant ($\times 400$); C. Lower portion of older plant ($\times 233$); D. Portion of thallus with gonidia ($\times 800$).

cushion-like basal disc; margins more or less crisped, oval or roundish in outline; cell-division over the whole frond, plastids parietal without pyrenoid, cells 4–7 μ in diam.

Usually epiphytic on other algæ. Very rare; Devon, Northumberland, Orkneys and Bute.

Distinguishable from *Porphyra* by the parietal plastids and small cells.

5. **ERYTHROPELTIS** Schmitz

(Gr. *eruthros*, red, and *pelte*, a shield.)

Differing from *Erythrotrichia* Aresch. in that the plant consists solely of a monostromatic disc, horizontally expanded, without erect filaments.

E. discigera Schmitz, var. **Flustræ** Batt.—Fronds rose-coloured, horizontally expanded, orbicular, becoming confluent and

irregular in outline; discs usually $50-150\mu$ in diam.; cells rounded-polygonal, oblong or irregular, $6-9\mu$ by $3-6\mu$; gonidia globose, about 9μ in diam.

On *Flustra foliacea*; Deal.

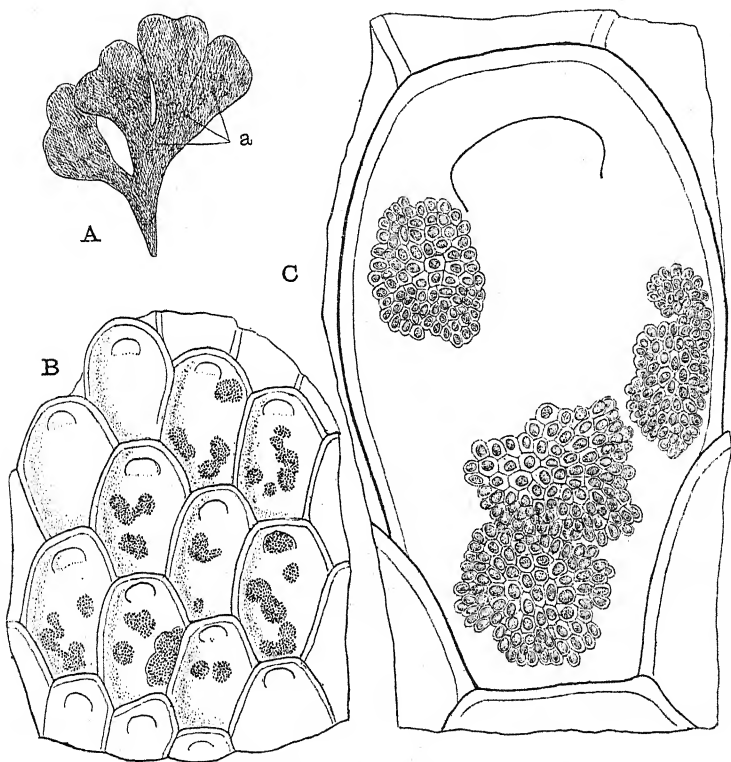


Fig. 149.—*Erythropeltis discigera* Schmitz, var. *Flustræ* Batt. A. Patches (a) on *Flustra foliacea* ($\times \frac{2}{3}$); B. the same ($\times 60$); C. the same ($\times 300$).

Tribe 3. *GONIOTRICHIEÆ*.—Gonidia arising without cell-division.

6. *GONIOTRICHUM* Kütz.

(Gr. *gonia*, an angle, and *trichion*, a small hair.)

Fronds filamentous, branching, composed of rose-coloured, disc-shaped cells, embedded in jelly; plastid star-shaped, central in the cell, with one pyrenoid. Gonidia produced in ordinary cells; the condensed cell-content is liberated as a naked spore. In water of a higher salinity than *Asterocytis*.

Key.

Filaments a single cell-row *G. elegans*.
 Filaments of 2 or more cell-rows, irregularly arranged *G. cornucervi*.

***G. elegans* Le Jolis (*Bangia elegans* Chauv.).**—Forming minute lilac tufts, 2–5 mm. or more in height; filaments several times pseudo-dichotomously branched, the branches cylindrical, curved, spreading, with very wide axils, obtuse at the tips; filaments up to 50μ thick below, becoming gradually thinner above; cells

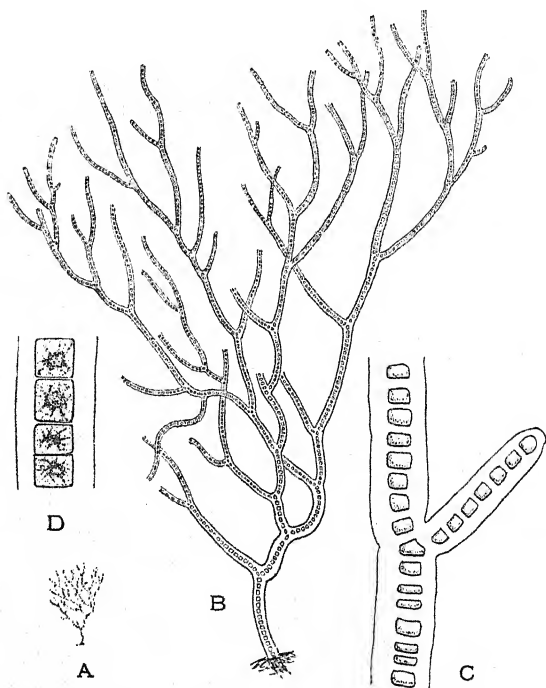


Fig. 150.—*Goniotrichum elegans* Le Jolis. A. ($\times 2$); B. ($\times 33$); C. Filament ($\times 300$); D. Small portion ($\times 430$).

variable in length, usually 1–3 times as long as broad, occasionally shorter; plastid star-shaped, with one central pyrenoid.

On the fronds of *Sphacelaria plumigera* and other small algæ. Not uncommon; widely distributed.

***G. cornu-cervi* Hauck.**—Lat. *cervus*, a stag, *cornu*, horn.—Filaments reddish violet, 0.2–1 mm. in height, 20 – 120μ in breadth; enclosed in hyaline sheath, enlarging abruptly above the base, irregularly dichotomous, of two, later of many rows of cells irregularly arranged; branches attenuate at the tips, often

consisting in that region of a single row of cells. Cells polygonal with rounded corners, 5–12 μ in diameter.

On various algæ. Rare; Devon.

7. ASTEROCYTIS Gobi

(Gr. *aster*, a star, and *kutis*, a vesicle.)

Fronds filamentous, branched, composed of blue-green sub-cylindrical or oval cells embedded in jelly; plastid star-shaped

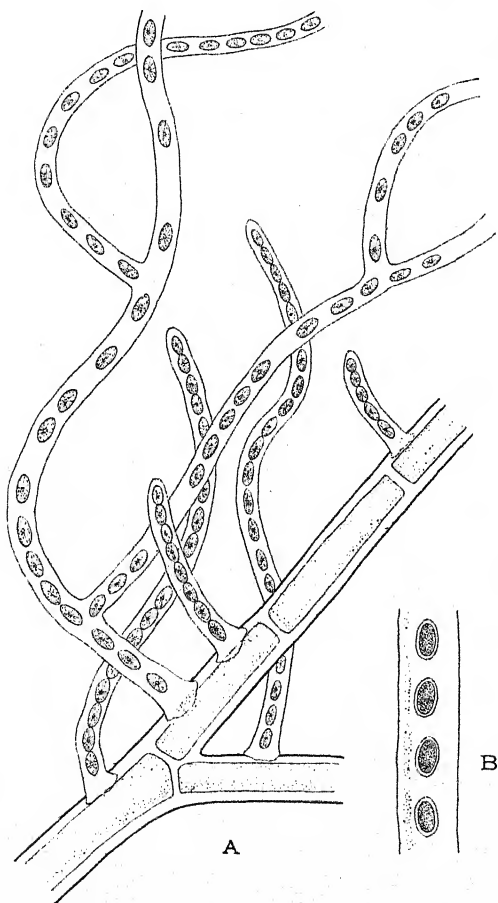


Fig. 151.—*Asterocytis ramosa* Gobi. A. On *Cladophora* ($\times 200$);
B. Gonidia? ($\times 500$).

with one pyrenoid, not always central in the cell. Reproduction by naked gonidia formed singly in the cells, escaping

through an opening in the unaltered gonidangial membrane ; also by thick-walled akinetes.

A. ramosa Gobi. (*Hormospora ramosa* Thwaites, *Goniotrichum ramosum* Hauck).—Forming blue-green tufts, 1–10 mm. high ; filament a single row of cells embedded in jelly, 12–20 μ thick, alternately or dichotomously branched ; cells 5–8 μ by 8–20 μ , cylindrically elongate or oval. Akinetes ellipsoidal or oblong, partly globular, 8.5–10.5 μ by 15 μ , surrounded by a thick wall formed from the innermost layers of the original membrane.

In shallow pools of brackish water. Very rare ; Dorset and Northumberland.

8. NEEVEA Batt.

(After J. T. Neeve, British naturalist.)

Thallus microscopic, endozoic, filamentous, procumbent, composed of violet or rose-purple cells arranged in a single row or two or more parallel rows within a gelatinous sheath ; filaments irregularly branched, in the older parts of the thallus united into a compact pseudoparenchymatous layer, one or more cells in thickness ; cells at first oval, becoming angular and very irregular by mutual pressure. Reproduction by gonidia.

The procumbent habit, parasitic mode of life, and the union of the filaments into a membranous layer distinguish the genus from *Goniotrichum* ; the irregular form of the layer from *Erythropeltis*.

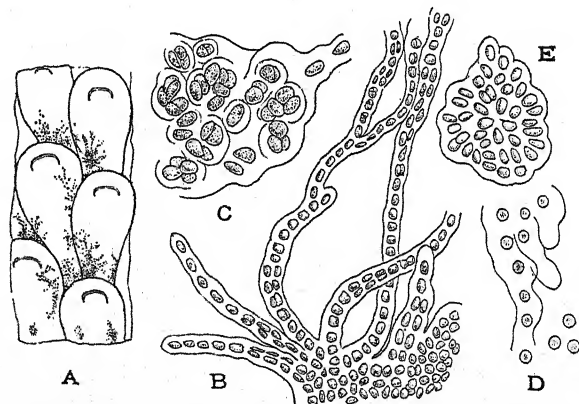


Fig. 152.—*Neevea repens* Batt. A. Growing in the substance of *Flustra foliacea* ($\times 33$); B. Portion enlarged ($\times 300$); C. Germinating gonidia ($\times 420$); D. Gonidia escaping ($\times 300$); E. Young plant ($\times 300$).

N. repens Batt.—Fronds from 0.25–1.5 mm. in diam. ; filaments 12–36 μ in breadth, in some parts containing a single row of cells, in others 2–8 rows ; cells 6–15 μ by 4–9 μ .

Endozoic in *Flustra foliacea*, causing pale pinkish stains.
Rare; Kent.

The following genus is placed here provisionally; cell walls have not been observed in gonidia formation.

9. CONCHOCELIS Batt.

(Gr. *konche*, a shell, and *kele*, a swelling.)

Thallus minute, formed of articulated branched filaments radiating from a central point in the young plants; later, forming a more or less compact, continuous, horizontal network in the superficial layer of the host; filaments below the horizontal layer swollen at intervals, the inflations being simple or branched. Gonidia formed in the swollen cells, one gonidium in each cell.

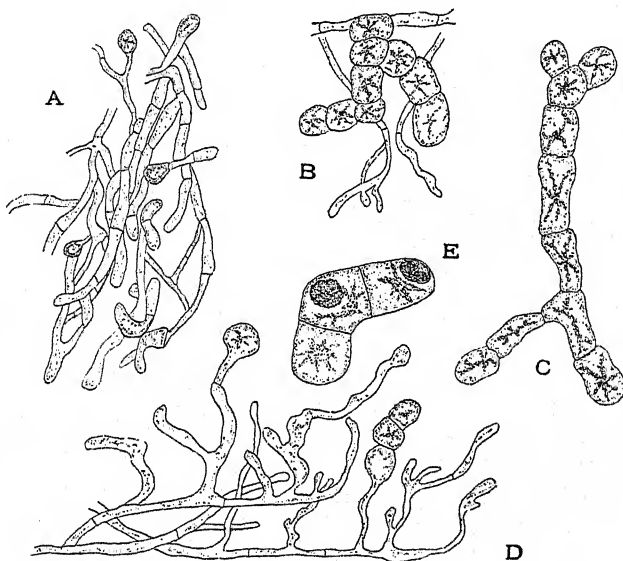


Fig. 153.—*Conchocelis rosea* Batt. A. Portion of horizontal network ($\times 170$); B. and C. Inflated cells showing plastids ($\times 170$); D. Portion showing vertical filaments ($\times 170$); E. Inflations during gonidia formation ($\times 200$).

C. rosea Batt.—Filaments $1.5-7.5\mu$ broad (usually about 4μ); cells irregular in shape, inflated cells $20-30\mu$ by $70-110\mu$; branching regular, lateral branches opposite or alternate, simple or, more frequently, branched, the lateral shoots sometimes anastomosing; inflations 2-10 cells long, each cell containing a star-shaped plastid. Gonidia globose, $13-15\mu$ broad.

Forming pink patches on the inner surface of the empty shells

of *Mya truncata*, *Solen vagina*, and others. Probably not uncommon; widely distributed.

Distinguished from *Ostreobium* by the pink, articulated filaments.

Subclass II.—FLORIDEÆ

Protoplasmic continuity between the cells obvious.

Order I.—NEMALIONALES

The fertilised carpogonium gives rise to branches which together form the gonimoblast. Auxiliary cells are absent, and all nourishment passing to the gonimoblast must go by way of the cells of the carpogonial branch.

Family I.—HELMINTHOCLADIACEÆ

Gonimoblast forming a cluster of branched filaments without a special envelope.

1. COLACONEMA Batt.

(Gk. *kolaks*, *kolakos*, a parasite, and *nema*, a filament.)

Thallus microscopic, consisting of rose-red, creeping, irregularly branched, jointed filaments; anastomosing or loosely united laterally. Monosporangia formed from portions of the terminal cells of principal axes or branches, or from a portion of a cell in the continuity of the filament, the undifferentiated portions of the cells forming cup-like bases for the sporangia. In the cell-walls of various algæ.

Key.

Cells 3–6 μ in diam.; in the walls of <i>Bonnemaisonia asparagoides</i>	<i>C. Bonnemaisoniæ</i> .
Cells 6–8 μ in diam.; in the cell-wall of <i>Desmarestia Dudresnayi</i>	<i>C. reticulatum</i> .

C. Bonnemaisoniæ Batt. From its host *Bonnemaisonia*.—Filaments flexuose, much and irregularly branched, anastomosing so as to form an irregular network between the cortical cells of the host-plant; cells variable in shape, simple, furcate, cruciate or irregular, swollen at intervals; from one to 8 or more times as long as broad, usually 3–6 μ in diam. Sporang. lateral, nearly globular, 9–12 μ broad, usually in clusters of from 2 to 6, cup-like base conspicuous.

In the cell wall of *Bonnemaisonia asparagoides*. Very rare; Devon and Northumberland.

C. reticulatum Batt.—Filaments much and irregularly branched, anastomosing so as to form a network between the cells of the host-plant; side-branches frequently adpressed

against the principal branches so that they appear to form one filament, composed of a double row of cells; cells short, angular, about as long as broad or slightly longer, $6-8\mu$ broad. Sporang. unknown.

In the cell-wall of *Desmarestia Dudresnayi*. Very rare; Devon and Donegal.

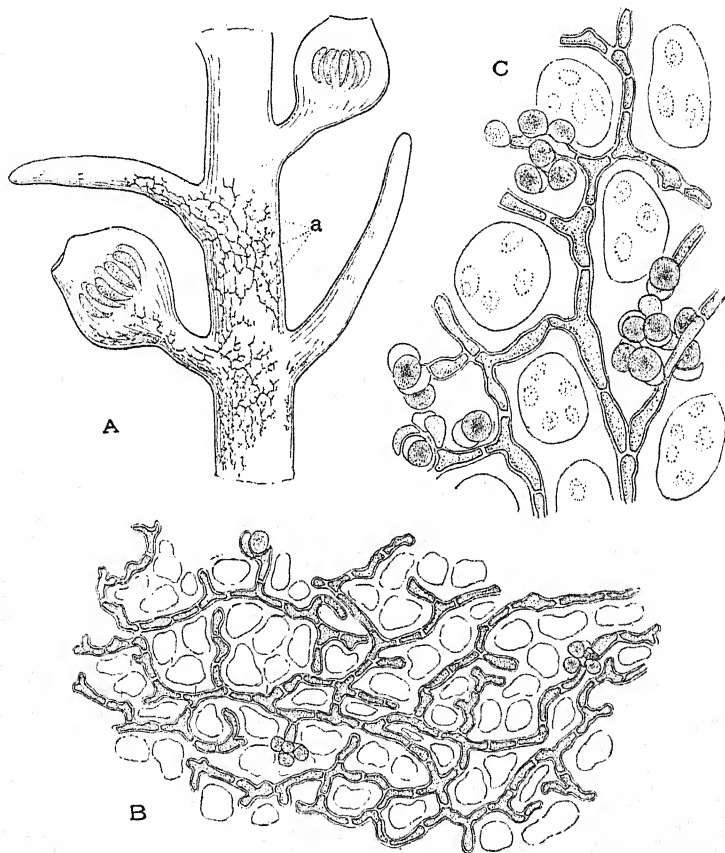


FIG. 154.—*Colaconema Bonnemaisonia* Batt. A. Growing in *Bonnemaisonia* (a) ($\times 60$); B. Ramifying among the cells of the host ($\times 300$); C. Filaments bearing sporang. ($\times 300$).

2. ACROCHÆTIUM Naeg.

(Gr. *akros*, topmost, and *chaite*, bristle.)

Plants parasitic, epiphytic or endophytic, filiform, irregularly branched, articulate, monosiphonous, branches often ending in

hairs, primary branches rhizoidal or haustorial. Cystocarps, antheridia, monosporangia and tetrasporangia may be present. Monœcious or dioecious, only in *A. efflorescens* is there a sharp distinction between sexual and sporangial plants.

Key.

1. Chromatophore ribbon-like, spiral *A. efflorescens* (11).
- Chromatophore of another form 2.
2. Frond epiphytic 3.
- Frond endophytic or endozoic or partially so 10.
3. Basal thallus a single cell 4.
- Basal thallus filamentous 5.
4. Mature plant consisting of three filaments in one plane, each 3 or 4 cells in length, sometimes terminating in a thin hair *A. trifilum* (4).
- Branching unilateral, often attenuate into long hairs *A. Battersianum* (5).
5. Filaments simple or sparsely branched *A. sparsum* (6).
- Filaments much branched 6.
6. Spores in close series on the upper side of the branches near their base *A. Daviesii* (10).
- Spores developed in another manner 7.
7. Articulations 3 times as long as broad below, 6 times their breadth in the branches ... *A. virgatum* (8).
- Articulations of another form 8.
8. Branches from the base often unilateral; monosporang. rarely solitary, usually corymbose *A. mirabile* (7).
- Branching lax or simple below and densely branched above 9.
9. Filaments simple below, densely branched above; spores secund or sometimes opposite *A. secundatum* (9).
- Branching lax; sporang. solitary, adaxial, borne near the summits of the main branches *A. Lorrain-Smithiæ* (14).
10. Basal thallus a single cell, sending out erect filaments and descending endophytic filaments *A. corymbiferum* (12).
- Basal thallus filamentous 11.
11. Frond endozoic 12.
- Frond endophytic 13.
12. In the outer wall of *Alcyonidium* *A. endozoicum* (3).
- In *Sertularia* spp. *A. Chylocladiæ f. pulchrum* (2).
13. In cell wall of *Chylocladia ovalis* *A. Chylocladiæ* (2).
- In other algæ 14.
14. Frond much and irregularly branched *A. endophyticum* (1).
- Branches few except near the surface and among deepest cells of host *A. sanctæ-mariæ* (13).

1. *A. endophyticum* Batt. Gk. *endon*, within, *phuton*, plant.—Microscopic; primary filaments decumbent, more or less swollen at intervals; much and irregularly branched, interwoven, forming a network from which very short, few-celled, erect filaments arise, breaking through the cortical layer of the host, and

terminating in a monosporang. Cells of decumbent filaments $6-18\mu$ by 3μ ; erect filaments about equal in breadth to decumbent, cells as long or a little longer than broad. Monosp. about 6μ in diam.

Endophytic in the cortical layer of *Heterosiphonia plumosa*. Very rare; Devon.

2. **A. Chylocladia** Batt.—Filaments slender, straight or very slightly flexuose, sub-simple or sparingly branched, two filaments sometimes united by one or more lateral branches; cells nearly cylindrical, very long, often 8 to 10 or 12 times longer than broad, $2.5-3\mu$ in diam.; sporang. terminal or lateral, oval, $6-8\mu$.

In cell-wall of *Chylocladia ovalis*. Very rare; Devon.

f. **pulchrum** Batt.—Parasitic in *Sertularia* spp. Coast of Bute.

3. **A. endozoicum** Hamel. Gk. *endon* within, *zoon*, animal.—Much branched; vegetative cells $7-25\mu$ by $7-13\mu$. Numerous fertile branches break through the wall of the host and form ovoid monosporang. 12 by 10μ , fertile branches as much as 85μ long, bearing few branchlets.

In the outer wall of *Alcyonidium gelatinosum*. Very rare; Northumberland and S.W. Ireland.

4. **A. trifilum** Batt. Lat. *tres*, three, *filum*, thread.—Frond minute, $27-30\mu$ long, arising from a single basal cell and consisting usually of 3 filaments each having 3-4 articulations, often terminating in a hair; articulations almost equal in length and breadth, $4-5\mu$ broad. Monosporang. spherical, $7-8\mu$ in diam., formed in 1 or 2 cells of the lateral ramuli.

On algæ. Very rare; Devon and Dorset.

5. **A. Battersianum** Hamel (*Chantransia microscopica* Batters).—Filaments $4-6\mu$ broad, articulations as long as broad or shorter than their breadth, branching unilateral, branches often attenuate into long hairs. Monosporang. sessile or stalked, solitary; anth. forming compact clusters at short intervals along main axes and branches, cyst. clustered near the base.

Epiphytic on other algæ. Very rare; Northumberland, Cornwall and Devon.

6. **A. sparsum** Naeg. (*Callithamnion sparsum* Carm.).—Forming small scattered clear crimson-red tufts of erect, closely-set filaments which are nearly simple or furnished with 2 or 3 simple, alternate or secund branches, equal in breadth to the main filament, cylindrical, obtuse; cells about $1\frac{1}{2}$ times as long as broad. Tetrasporang. obovate, sessile, mostly axillary.

Epiphytic on other algæ. Rare; widely distributed.

7. **A. mirabile** Naeg.—Fronds tufted, 1-2 mm. high, rose-red; filaments $8-12\mu$ broad, often bearing unilateral branches from the base, the branches themselves bearing lateral ramuli; articulations twice as long as broad, branches attenuate into fine

hairs. Monosporang. oval, pedicellate, rarely solitary, often corymbose, 5-10 or more arising on the upper branches.

On other algæ. Rare; Dorset.

8. *A. virgatulum* J. G. Agardh (*Callithamnion virgatulum* Harv.). Lat. *virga*, a rod.—One or many filaments arising from a basal disc; filaments 10-14 μ broad below, 6-8 μ near the end of the long erect branches, which often terminate in a hair; cells 3 times as long as broad below, 6 times their breadth in the branches; ramuli short, mostly 1-3 celled, abundant, scattered, opposite or in short second series, bearing hairs or terminal sporang., the latter also borne on the branches, sessile, 12 μ by 20 μ . Main characters of the species are long sub-simple branches with short ramuli or spores on nearly every cell and abundant hairs arising abruptly from the terminal cells.

On various algæ. Not uncommon; widely distributed.

f. *luxurians* Rosenv.—Occurring as a continuous fringe on the surface of *Zostera marina*, the basal discs being practically continuous.

f. *tetrica* Rosenv.—Tetraspores on short opposite branches. Clare Island.

9. *A. secundatum* Naeg.—Several filaments arising from a disc, usually 2 cell-layers thick; filaments 9-12 μ in diam. below, simple for a short distance, then densely branched; branches rather patent, unequal in length, at first secund, later often opposite, 6-8 μ broad near the tip, often terminating in a hair; cells 1½ to twice as long as broad in the main filaments, 2-3 times their breadth in the branches. Spores 10 μ by 18 μ , sessile or shortly stalked, secund or sometimes opposite.

On various algæ, especially *Porphyra*. Common; widely distributed.

Similar to *A. virgatulum* but shorter and more densely branched, with uniformly shorter cells and branching predominantly secund.

10. *A. Daviesii* Naeg. After Rev. Hugh Davies, Welsh naturalist.—Arising from a layer of branched creeping filaments, often interwoven to form a disc, erect filaments 10-12 μ in diam. near the base, slightly smaller upwards, branches abundant, largely secund, rather erect; cells 2-4 times as long as broad. Spores 10-12 μ by 15-20 μ , sessile or shortly stalked, in close series on the upper side of the branches near their base; hairs more or less abundant.

Forming a fringe on the edge of *Rhodymenia palmata* and other algæ. Not uncommon; widely distributed.

Distinguished from other species by arrangement of spores.

11. *A. efflorescens* Naeg. Lat. *efflorescens*, flourishing.—Sexual plants in isolated tufts 3-5 mm. long, asexual plants in a continuous felted layer about 2 mm. high. Filaments usually 5-6 μ thick, with plastids forming parietal spiral bands. Mono-

sporangia $11-18\mu$ by $5-6\mu$, tetrasporang. $15-28\mu$ by $8-12.5\mu$. Carpogonia lateral or intercalary, often grouped; antherid. often produced near the carpogonia.

On algæ, tubes of Hydroids, Ascidiæ, shells of *Buccinum* and on stones, sometimes penetrating wall of host. Rare; Dorset.

Rhodochorton chantransioides Reinke represents asexual generation with tetrasporang.

12. *A. corymbiferum* Batt. Lat. *corymbiferus*, bearing a cluster of berries.—Filaments erect and straight, about 8μ in diam., slightly tapering above; branches few below, more abundant above, alternate or somewhat secund, virgate, ramuli few; cells 3-10 times as long as broad. Spores sessile or shortly stalked. Cystoc. formed of a dense mass of naked spores

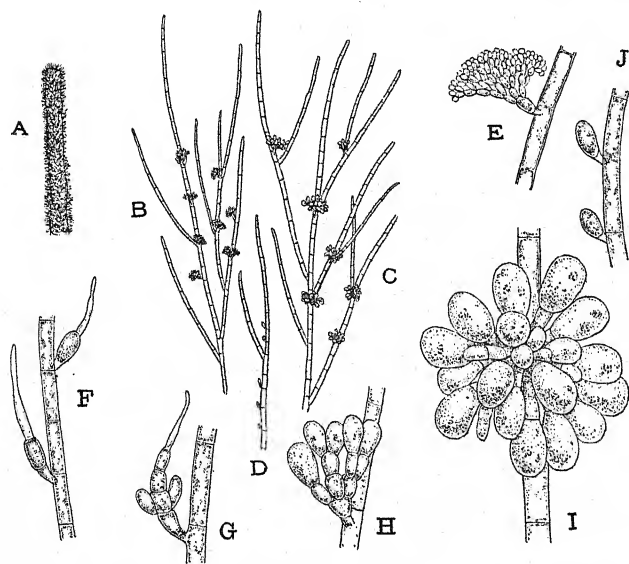


Fig. 155.—*Acrochaetium corymbiferum* Batt. A. On *Helminthocladia purpurea* ($\times \frac{3}{2}$); B. with antheridia ($\times 86$); C. with cystocarps ($\times 86$); D. with monospores ($\times 86$); E. antheridia ($\times 400$); F. to I. stages in the development of the cystocarp ($\times 400$); J. monospores ($\times 400$).

arising near the base of the branch; antherid. on separate plants in dense shortly stalked masses in the same relative position. The original spore, $12-15\mu$ in diam., persisting at the base, sends down a branching filament into the host, from which secondary filaments may arise.

On *Helminthocladia purpurea*. Ireland.

13. *A. sanctæ-mariæ* Hamel.—Living entirely endophytically, except for the outer walls of the sporangia. Filaments extending in a radial direction to a depth of over 0.4 mm., the cells remaining coloured; branches few except near the surface of the host for sporangia-formation, and among the deepest cells of the host, presumably for food-absorption; cells 9–11 μ broad, rather shorter than their breadth. Monosporangia formed near the surface of the host, about 15 μ long.

In the fertile fronds of *Himanthalia lorea*. St. Mary's Island, Northumberland.

14. *A. Lorrain-Smithiæ* Newton (*Chantransia Lorrain-Smithiæ* Lyle). After A. Lorrain Smith.—Frond erect, arising from a pseudoparenchymatous layer; filaments 4–9 mm. long, branching lax; articulations 40–60 μ by 15–20 μ broad; branches obtusely attenuate at the apices, bearing adaxial ramuli. Monosporang. adaxial, oval, pedicellate or sessile, 30–35 μ by 15–20 μ .

Guernsey.

Differs from *A. Daviesii* in lax disposition of sporangiferous branchlets situated towards the summits of the main branches, whereas in *A. Daviesii* the sporang. branches are longer, more numerous and crowded in or near the axils of the secondary branchlets on any part of the filament.

3. NEMALION Duby

(Gr. *nema*, a thread.)

Thallus terete, simple or dichotomously branched, gelatinous, consisting of a pseudoparenchymatous central zone of filaments closely united together, and a loose zone of di-trichotomously branched moniliform assimilating filaments at right angles to the surface. Cystoc. formed between the assimilating filaments; antherid. in clusters on the tips of the peripheral filaments; tetrasp. unknown.

Key.

Frond simple or divided once at the base	<i>N. elminthoides</i> .
Frond dichotomously branched	<i>N. multiffidum</i> .

N. elminthoides Batt. (*Nemalion lubricum* Duby). Gr. *elminthodes*, like a worm.—Thallus very elastic, firmly gelatinous or somewhat cartilaginous, brown or reddish brown; 10–25 cm. long, 2–5 mm. diam., simple or once branched at the base.

Usually monœcious. Local; S. England, Scotland and Channel Islands.

N. multiffidum, J. G. Agardh. Lat. *multiffidus*, many cleft.—Thallus gelatinous or cartilaginous, brownish purple, 10–25 cm long, 1–3 mm. diam.; dichotomous, the axils rounded, cylindrical, apices slightly attenuate, blunt; attached by a parenchymatous expanded disc.

Usually monœcious, sometimes dioecious. Rather rare; widely distributed.

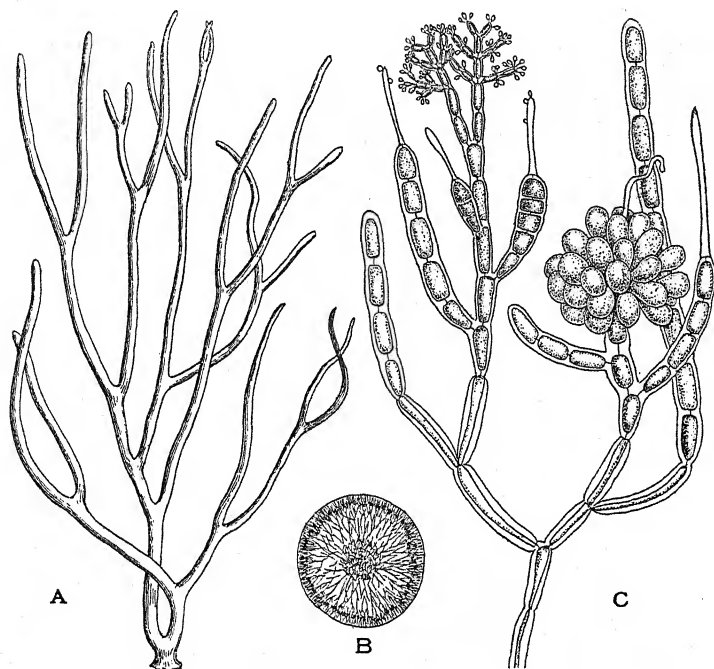


Fig. 156.—*Nemalion multifidum* J. G. Agardh. A. ($\times \frac{3}{8}$); B. Trans. sect. of thallus ($\times 6$); C. Antheridia and cystocarps in various stages of development ($\times 300$).

4. **HELMINTHOCADIÆ** J. G. Agardh (non Harv.)

(Gr. *helmins*, a worm, and *klados*, a branch.)

Thallus a gelatinous axis bearing lateral branches, the structure resembling that of *Nemalion*, except that the assimilating filaments are formed of larger cells, of which the clavate terminal cell is the largest. In the adult plant no hairs are present, though in the young stages they may be seen borne somewhat laterally near the tips of the assimilating filaments. Antherid. form hemispherical clusters at the ends of the assimilative filaments; cystoc. lateral on the peripheral filaments.

Key.

Frond constricted at intervals *H. Hudsoni*.
Frond attenuate at base and apex but not constricted *H. purpurea*.

H. purpurea J. G. Agardh (*Nemalion purpureum* Chauv.).—Thallus gelatinous and slippery, not very elastic; 30–50 cm.

long, 3-6 mm. diam. ; central axis usually undivided, bearing numerous irregularly inserted, elongated simple branches, either naked or bearing a second series of branchlets ; main axis attenuate at base and apex, branches attenuate at their apices. Colour varying from deep purple-red to dull pink, rapidly given out in fresh water, becoming darker in drying.

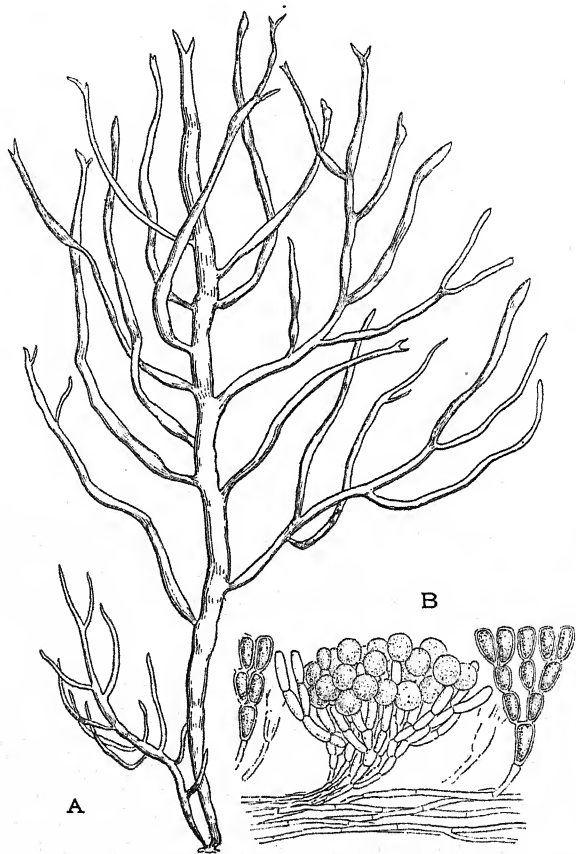


Fig. 157.—*Helminthocladia purpurea* J. G. Agardh. A. ($\times \frac{3}{4}$); B. Portion showing cystocarp ($\times 300$).

In sandy places, among *Zostera*, near low-water mark. Very rare; S. England, Ireland and Isle of Man.

H. Hudsoni J. G. Agardh.—Thallus 7-10 cm. long, terete, gelatinous, brownish in the axis, purple in the branches; constricted irregularly at intervals; branching irregular, often

dichotomous ; branches thin, cylindrical, subclavate, lateral on the main axis.

Very rare ; Cornwall and Devon.

5. **HELMINTHORA** J. G. Agardh

(Gr. *helmins*, a worm, and *thore*, sperm.)

Thallus terete, gelatinous, elastic ; lateral branches numerous, bearing a second series of branchlets, arising from the central axis ; inner layer pseudoparenchymatous, bearing numerous

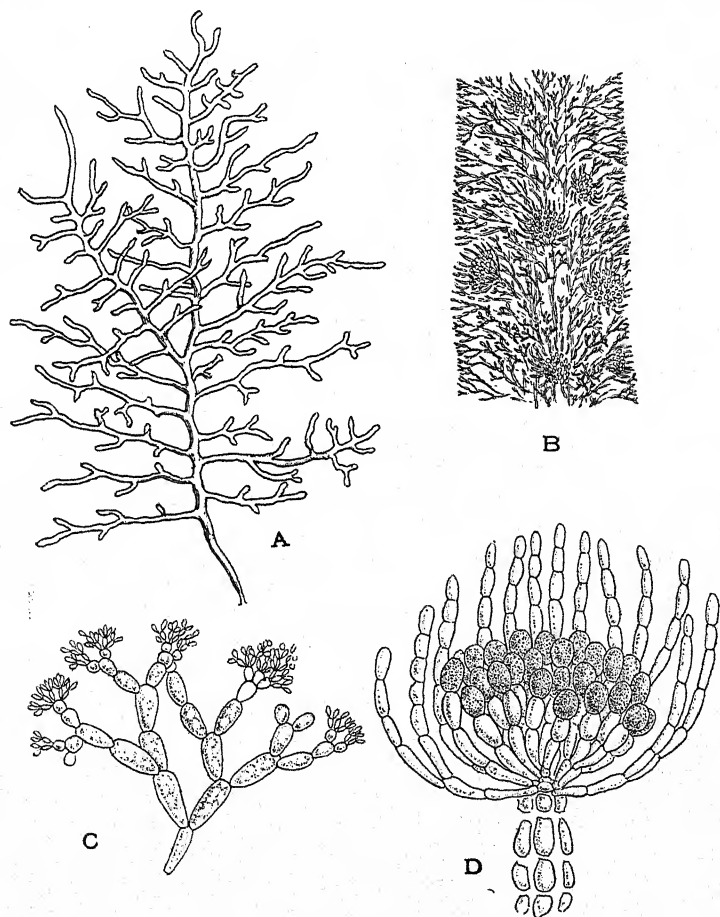


Fig. 158.—*Helminthora divaricata* J. G. Agardh. A. ($\times \frac{3}{8}$); B. Portion bearing cystocarps ($\times 60$); C. Antheridia ($\times 300$); D. Cystocarp ($\times 300$).

dichotomous moniliform assimilating filaments, each terminating in a long hair, at right angles to the surface of the frond. Cystoc. lateral on the assimilative filaments, enclosed in whorls of moniliform filaments; antherid. in clusters at the tips of the peripheral filaments; tetrasp. unknown.

Distinguishable from *Nemalion* and *Helminthocladia* by the distinctly limited inner axis, bearing the assimilating filaments.

H. divaricata J. G. Agardh (*Dudresnaya divaricata* Harv.). Lat. *divaricare*, to spread asunder.—Densely tufted, 15–20 cm. long, firmly gelatinous and elastic, pale red or red-brown; main branches somewhat attenuate at the base and apex, lateral branches almost equal in thickness throughout; shorter near the apex of the plant, giving an ovate outline to the frond; main axis simple or forked, bearing numerous lateral branches almost at right angles which bear secondary branches all very patent, horizontal or divaricate, alternate, opposite or bipinnate; ramuli numerous, filiform, squarrose.

On stones and the smaller algæ, near low-water mark, and at greater depth. Locally abundant; not generally distributed.

Family II.—CHÆTANGIACEÆ

Gonimoblast sunk in the thallus, surrounded by a pericarp.

SCINAIA Bivona

(After Domenico Scina, Italian naturalist.)

Fronds subgelatinous, cylindrical or compressed, dichotomously branched, composed of slender colourless filaments and a zone of horizontal filaments ending in short corymbs of round assimilative cells. In the centre of each corymb is a large colourless cylindrical cell; the juxtaposition of these cells forms an epidermal layer. Cystoc. borne just below the cortical layer; antherid. in small tufts on the superficial cells.

S. furcellata Bivona (*Ginnania furcellata* Mont.). Lat. *furcilla*, a little fork.—Fronds subsolitary or several growing together, 5–25 cm. long, brownish red to clear pink, firmly membranaceous or tender and gelatinous; cylindrical or slightly compressed, more or less attenuate at the base, repeatedly and regularly dichotomous, tufts fastigate; apices usually obtuse, occasionally attenuate; frond sometimes constricted at intervals.

On rocks, stones, oyster-shells, etc., from low-water mark to 8 or 10 fathoms. Rather rare; widely distributed.

var. **subcostata** J. G. Agardh—Broader than the type, constricted at intervals. Rare; Devon, Bute and Cork.

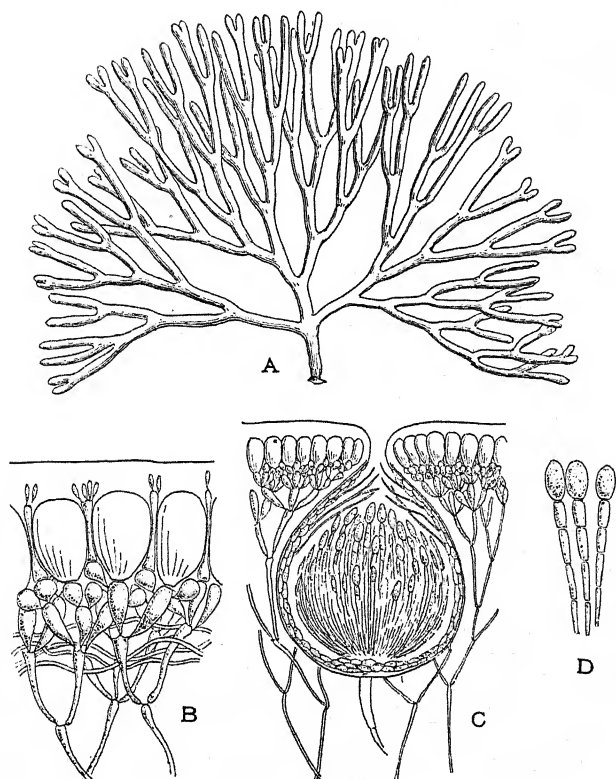


Fig. 159.—*Scinaia furcellata* Bivona. A. ($\times \frac{2}{3}$); B. Showing large colourless cells and antheridia ($\times 400$); C. Cystocarp ($\times 95$); D. Carpospores ($\times 400$).

Order II.—GELIDIALES

The group has been separated from the Nemalionales on account of the presence of auxiliary cells in the carpogonium.

Family I.—GELIDIACEÆ

Cystoc. immersed in swollen branches, carposp. borne on an axile or parietal placenta; tetrasp. cruciate, borne in the cortical layer; antherid. in superficial patches.

1. **GELIDIUM** Lamour.

(*Lat. gelidus*, congealed [after boiling or maceration].)

Frond cartilaginous, terete or compressed; compound pinnate branching axis formed of long cylindrical cells around a central siphon, surrounded by roundish cells becoming small and polygonal at the surface. Cystoc. immersed in swollen branches, containing oblong or pyriform spores on an axile placenta, attached by filaments to the walls of the cystoc.; ostioles two, one on each side of the frond; antherid. in superficial patches; tetrasp. cruciate, scattered in the cortex.

Key.

- | | | |
|---------------------------------------------------------------------------------------|----|-----------------------------|
| 1. Main branches capillary, terete or nearly so | 2. | |
| Main branches more or less compressed..... | 4. | |
| 2. Plants 5-20 mm. high, erect; procumbent filaments forming a felted mass | | <i>G. pusillum</i> (2). |
| Procumbent filaments not forming a felted mass... | 3. | |
| 3. Pinnæ short, patent, acute | | <i>G. crinale</i> (1). |
| Pinnæ between linear and clavate, obtuse | | <i>G. pulchellum</i> (4). |
| 4. Turning violet-black on drying, very few inter-cellular filaments in tissue | | <i>G. melanoideum</i> (9). |
| Not turning violet-black on drying | 5. | |
| 5. Fronds broad, flat or nearly so, fringed with numerous short setaceous pinnæ | | <i>G. latifolium</i> (7). |
| Not so | 6. | |
| 6. Substance very rigid | 7. | |
| Substance not rigid | 8. | |
| 7. Ramuli few, short, obtuse, attenuate at the base ... | | <i>G. sesquipedale</i> (8). |
| Ramuli numerous, attenuate at the apices | | <i>G. attenuatum</i> (5). |
| 8. Ramuli minute, divaricate, crowded towards the summit of the frond | | <i>G. aculeatum</i> (3). |
| Ramuli opposite or alternate, patent, obtuse, clothing the frond | | <i>G. corneum</i> (6). |

The variability is so great that identification of varieties can be accomplished only by careful comparison with the type specimens. No attempt has been made to separate them in the key.

1. **G. crinale** J. G. Agardh (*G. corneum* var. *crinale* auct.). *Lat. crinalis*, pertaining to hair.—Fronds caespitose, dark purple, 2.5-7.5 cm. long, primary axis procumbent, from which arise erect, sub-terete, once or twice pinnate branches; pinnæ distichous, alternate, short, patent, acute, often pinnatifid. Tetrasp. cruciate in thickened subspathulate or pinnatifid apices.

Forming tufts on rocks and stones at low-water mark. Not uncommon.

var. **lubricum** Hauck (*Acrocarpus lubricus* Kütz.).—Tufts 2-3 cm. high, thallus 100-300 μ thick, terete or flattened, sparsely branched, apices of the sterile branches attenuate. Cystoc. forming oval swellings in the branchlets; tetrasp. and antherid. in swollen branchlets. Rare; Dorset and Sussex.

var. *spatulatum* Hauck (*Acrocarpus spatulatus* Kütz.).—Tufts 2–5 cm. high, very dense; thallus 200–500 μ broad, branching usually alternate, rarely opposite, simple or pinnate; pinnæ spindle-shaped or more elongated. Rare; Devon and Bute.

var. *polycladum* Hauck (*Gelidium polycladum* Kütz.).—Thick tufts 1–2 cm. high; thallus filamentous. Rare; Dunbar and Cumbrae.

2. *G. pusillum* Le Jol. (*G. corneum* var. *clavatum* Grev. and var. *cæspitosum* J. G. Agardh). Lat. *pusillus*, very small.—Fronde capillary, between cartilaginous and membranous, decumbent, creeping; ramuli inversely lanceolate or ovate, markedly attenuate at the base, alternate or irregularly arranged.

Common in the south of England, much rarer in Northern England and Scotland.

3. *G. aculeatum* Batt. (*G. corneum* var. *aculeatum* Grev.). Lat. *aculeatus*, prickly.—Fronde compressed, very thin, very regularly pinnate, pinnæ divaricate, irregularly divided and set with minute, divaricate, subulate ramuli, crowded towards the summit of the frond.

Rare; widely distributed.

var. *abnorme* Batt. (*G. corneum* var. *abnorme* Grev.).—Fronde compressed, irregularly branched; branches and pinnæ producing at their extremities little tufts of partly deflexed ramuli. Rare; Cornwall, Devon and Bute.

4. *G. pulchellum* Kütz. Lat. *pulchellus*, beautiful little.—Fronde capillary, compressed, bi-tripinnate; pinnæ between linear and clavate, obtuse.

Rare; widely distributed.

var. *setaceum* Batt. (*G. corneum* var. *setaceum* Kütz.).—Angles less widely divergent than the type. Rare; Galway and Channel Islands.

var. *claviger* Batt. (*G. corneum* var. *clavigerum* Grev.).—Fronde subcylindrical, capillary, irregularly divided; the penultimate ramuli or pinnulæ obovate, clothed with numerous minute branchlets. Rare; Dorset and Cork.

5. *G. attenuatum* Thur. (*G. corneum* var. *attenuatum* Hook.). Lat. *attenuatus*, reduced.—Fronde 10–20 cm. long, very rigid, reddish purple, cæspitose, branched almost from the base; branches pinnate, compressed, apices gradually attenuate; ramuli 2–3 mm. long, linear-lanceolate; secondary ramuli distichous, sub-opposite, filiform, acute. Fructification unknown.

Rare; Devon and Dorset.

var. *confertum* Batt. (*G. corneum* var. *confertum* Grev.).—Fronde compressed, repeatedly pinnate; pinnæ and pinnulæ long, very thin, acute and irregularly divided. Rare; widely distributed.

6. *G. corneum* Lamour. Lat. *corneus*, horny.—Fronde

between cartilaginous and horny, somewhat flattened, distichous; branches linear, attenuate at each extremity, pinnate or bipinnate; pinnules opposite or alternate, patent, obtuse.

On rocks, from the verge of high-water mark to the extreme of low water and at greater depth; often in tide-pools shaded by other algæ, and near the entrance of caves. Not uncommon; widely distributed.

7. *G. latifolium* Born. (*G. corneum* var. *latifolium* Grev., var. *plumula* Kütz.). Lat. *latus*, broad; *folium*, leaf.—Fronde broad, nearly flat, pinnæ linear-lanceolate; mostly simple, set with numerous, short, setaceous pinnæ.

Probably not uncommon; widely distributed.

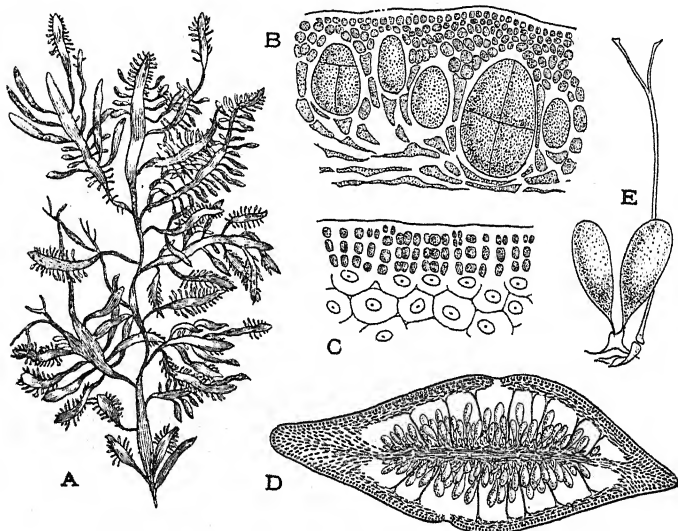


Fig. 160.—*Gelidium latifolium* Born. A. ($\times \frac{3}{4}$); B. Section of thallus showing tetrasporang. ($\times 260$); C. Section of thallus showing production of spermatia ($\times 600$); D. Trans. sect. of cystocarp with two ostioles ($\times 50$); E. Carpospores and adjacent filament ($\times 260$).

var. *hystrix* Hauck (*G. corneum* var. *hystrix* J. G. Agardh).—Thallus usually compressed; the lower parts or the whole plant sometimes almost terete, bearing elongated lateral branches, often opposite, the whole thallus being clothed with ramuli arising on all sides of the branches or bi-laterally arranged. Very rare; Dorset.

var. *laciniata* Batt. (*G. corneum* var. *laciniatum* Kütz.).—More lacinate than the type. Very rare; Devon.

var. *flexuosum* Batt. (*G. corneum* var. *flexuosum* Harv.).—Fronde rather broad, flat, very flexuose, pinnate or sub-bipinnate;

pinnæ curved, attenuate at each end, subulate. Very rare ; Cornwall and Devon.

8. *G. sesquipedale* Thur. (*G. corneum* var. *sesquipedale* Grev.). Lat. *sesquipedalis*, one foot and a half in length.—Frond rigid, 10–20 cm. long, slightly compressed or flat, linear, tripinnate ; pinnæ attenuate at the base ; ramuli linear, oblong, short, obtuse.

Rare ; Devon.

9. *G. melanoideum* Schousb. *Gr. melanooides*, black-looking.—Frond compressed, horny, brownish black, violet-black when dry ; branching pinnate, corymbose in the upper parts ; ramuli sub-opposite. Fructification in swollen cylindrical apices, obtuse, borne in tufts. Distinguished from other species by the small number of intercellular filaments which develop in the tissue.

Very rare ; Dorset.

var. *filamentosa* Schousb.—Fronds with elongated capillary branches. Very rare ; Sussex and Northumberland.

Species inquirenda.

G. torulosum Kütz.—Plant 5–8 cm. in height. Fronds lax, very narrow, flat, irregularly tripinnate or much divided above ; pinnæ opposite, patent, with constricted articulations. Cystoc. borne on terminal swollen branches.

Guernsey.

2. PTEROCLADIA J. G. Agardh

(*Gr. pteron*, a wing, and *klados*, a branch.)

Thallus compressed, pinnately branched, when young having a conspicuous central axis, later often becoming tufted. Thallus consisting of a central siphon, surrounded by a loose parenchymatous tissue ; cells becoming smaller near the periphery, being finally bounded by a superficial layer of moniliform cells at right angles to the surface. Cystoc. in the thallus, having only one loculus and one ostiole ; antherid. developed from the surface cells ; tetrasp. near the apices of the branchlets, cruciate, formed in the cortex.

Differing from *Gelidium* in having only one loculus and one ostiole in the cystoc.

P. capillacea Born. (*Gelidium corneum* vars. *capillaceum*, *uniforme* and *pinnatum* Grev.). Lat. *capillus*, hair.—Thallus in tufts, 5–15 cm. long, compressed, 3 or 4 times pinnately branched, the smaller branches often attenuate at the base.

On rocks, from high-water mark to extreme low-water mark and deeper ; often in places shaded by other algæ or overhanging rocks. Not uncommon ; widely distributed.

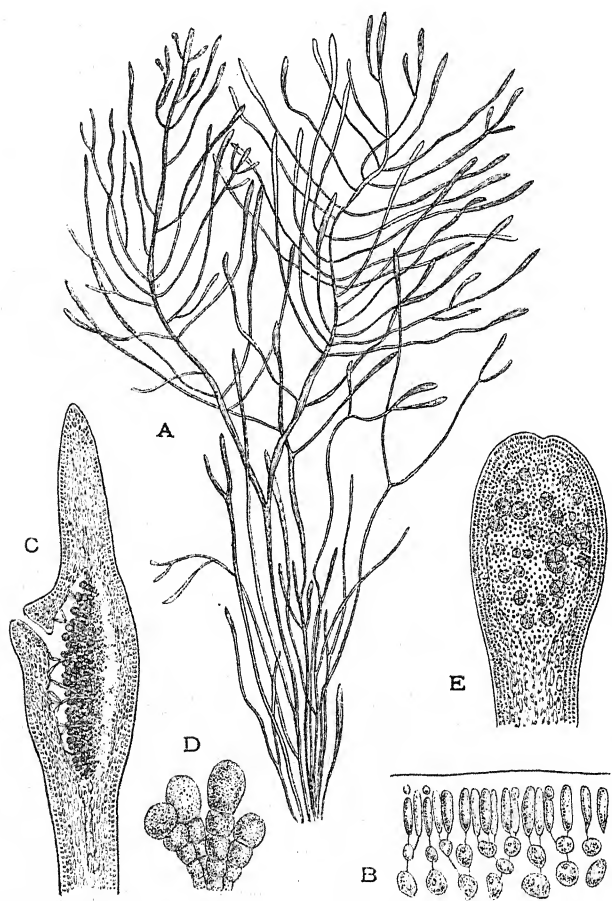


Fig. 161.—*Pterocladia capillacea* Born. A. ($\times \frac{2}{3}$); B. Trans. sect. of thallus showing spermatia ($\times 440$); C. Trans. sect. of cystocarp showing single ostiole ($\times 60$); D. Carpospores ($\times 160$); E. Apex of branch with tetraspores ($\times 60$).

Family II.—WRANGELIACEÆ

Thallus filamentous with monosiphonous axis, corticate or ecorticate. Cystocarps oval or pear-shaped, with a pericarp or surrounded only by loose filaments.

1. **ATRACTOPHORA** Crouan(Gr. *atraktos*, spindle, and *phoreo*, I bear.)

Frond filiform, branched, subgelatinous, formed of articulated filaments; branches bearing ramuli, their apices clothed with whorls of dichotomous fibrillæ. Axis consisting of a large articulated central siphon and a cortical layer formed of many

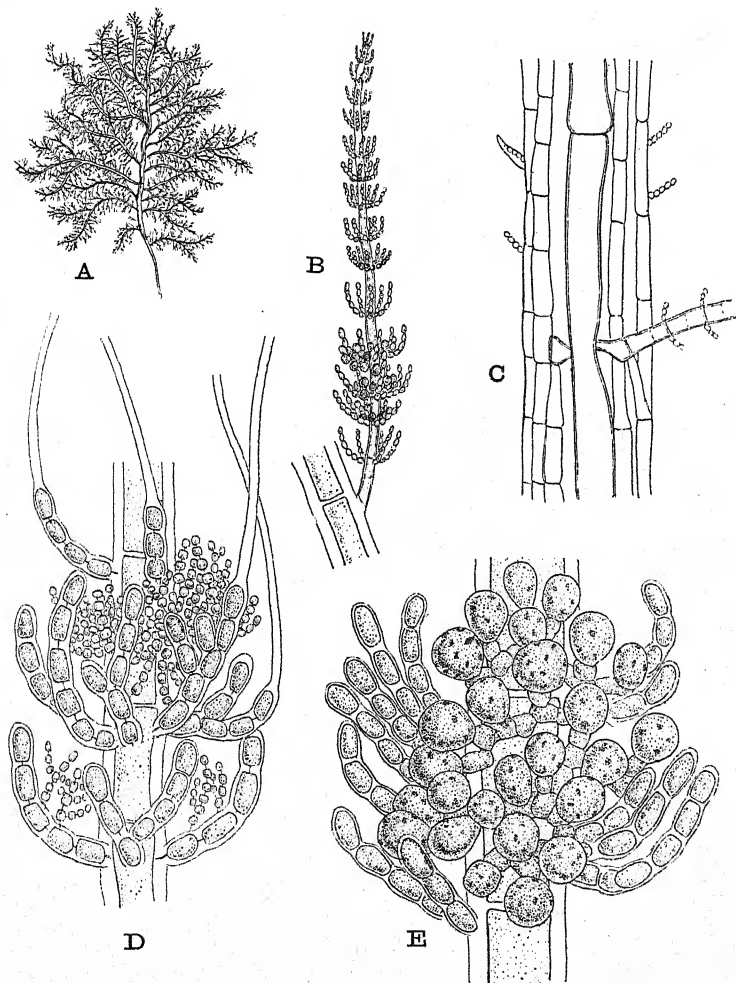


Fig. 162.—*Atractophora hypnoides* Crouan. A. ($\times \frac{3}{4}$); B. Ramulus ($\times 60$); C. Section of thallus ($\times 45$) (after Bornet and Thuret); D. Antheridia ($\times 300$); E. Cystocarp ($\times 300$).

rows of articulated cells 10–12 times smaller in diameter than the axial tube. Cystoc. formed at the base of the whorled filaments, the latter when fertile being attenuate at each extremity; spores small, numerous, pyriform.

A. hypnoides Crouan.—Fronde clear red, 6–12 cm. long, 1–3 mm. in diameter at the base, attenuate towards the apex, filiform, branched, the branches pyramidal; ramuli alternate, nearly opposite or verticillate, incurved or straight.

Very rare, occurring on other algæ. Devon, Dorset, and the Channel Islands.

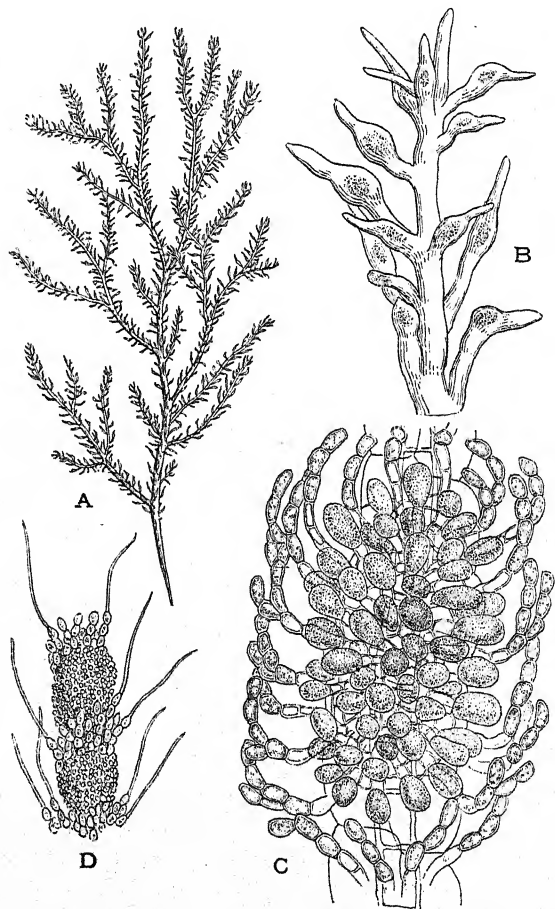


Fig. 163.—*Naccaria Wiggthii* Endl. A. ($\times 3$); B. Portion with cystocarps ($\times 60$); C. Cystocarp ($\times 300$); D. Spermatia near apex of branch ($\times 300$).

2. NACCARIA Endl.

(After Aloysio Fortunato Naccari, Italian botanist.)

Thallus gelatinous, consisting of a central axis and numerous branches irregularly arranged, themselves bearing secondary branches and ramuli attenuate at base and apex. Cystoc. oval or elongated, traversed by a central axis bearing the sporogenous filaments; antherid. in dense groups, near the apices of the branches; tetrasp. unknown.

N. Wigghii Endl. After Mr. Lilly Wigg, English algologist.—Thallus bright rose-red, 5–30 cm. high, pyramidal in form, 50–100 μ thick in the smallest branches, 1–2 mm. in the largest; ramuli 1–4 mm. long, clothing main axis and branches. Thallus consisting in trans. sect. of one central cell, and a wide band of loosely arranged colourless cells, bounded by a zone of small assimilative cells.

On rocks, at and below low-water mark. Rare; widely distributed.

3. BONNEMAISONIA C. A. Agardh

(After Théophile Bonnemaison, French naturalist.)

Thallus filamentous, terete or compressed, much branched, the branches margined with distichous, subulate, alternate ramuli; composed of one thin-walled central siphon and two or more lateral ones, surrounded by a single row of large thin-walled cells, bounded by a layer of small cells diminishing centrifugally and forming the outer assimilative layer. Cystoc. elongated or almost egg-shaped with a terminal ostiole, shortly stalked; antherid. on the branches in lateral groups. Tetrasp. unknown.

Key.

Pinnæ of two kinds	<i>B. hamifera.</i>
Pinnæ of one kind	<i>B. asparagoides.</i>

B. asparagoides C. A. Agardh.—Fronds soft, crimson, solitary or tufted, 10–30 cm. long, usually compressed, rarely cylindrical; central axis prominent, bearing alternate, closely packed, patent branches, longest below, giving the frond an ovate outline; lower branches similar to the main axis, furnished with a second, third, or even fourth series of lesser branchlets, upper branches less divided; the whole frond clothed with alternate ramuli. Cystoc. on the branches opposite the ramuli, stalked, ovate, with terminal ostiole.

On rocks, near low-water mark, and at greater depth. Rare; widely distributed.

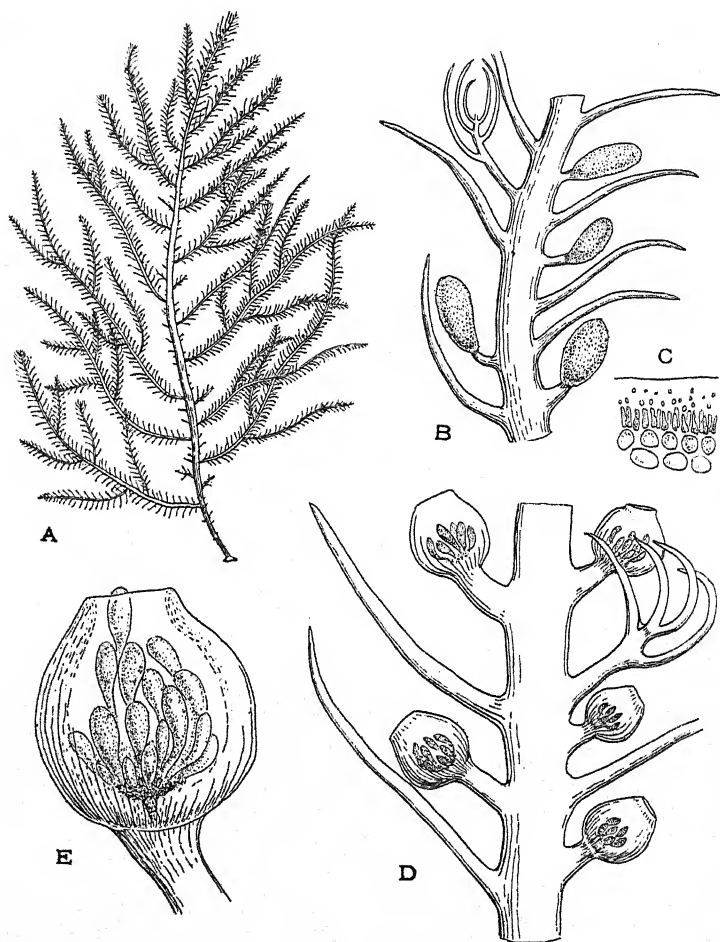


Fig. 164.—*Bonnemaisonia asparagoides* C. A. Agardh. A. ($\times \frac{1}{2}$); B. Portion with spermatia ($\times 35$); C. Spermatia ($\times 250$); D. Portion with cystocarps ($\times 35$); E. Single cystocarp ($\times 65$).

var. *teres* Harv. — Frond capillary, terete; ramuli very long.

B. hamifera Hariot. Lat. *hamus*, a hook; *fero*, I bear. — Frond deep red, filiform, 6–7 cm. long, pinnately branched, branches and ramuli alternate; ramuli 5 mm. long, of two kinds, some pinnulate, some inflated, apices hooked. Cystoc. pedicellate, alternating with the ramuli.

Very rare; Cornwall, Devon and Isle of Wight.

Order III.—CRYPTONEMIALES

Auxiliary cells present in the cystocarp, but their function is not solely nutritive as in the *Gelidiales*.

Family I.—GLOIOSIPHONIACEÆ

Carpogonial branch and auxiliary organ united into a procarp which originates as a solitary cell from one of the vegetative branches springing from the central axis. No special pericarp and cystocarpic pore developed.

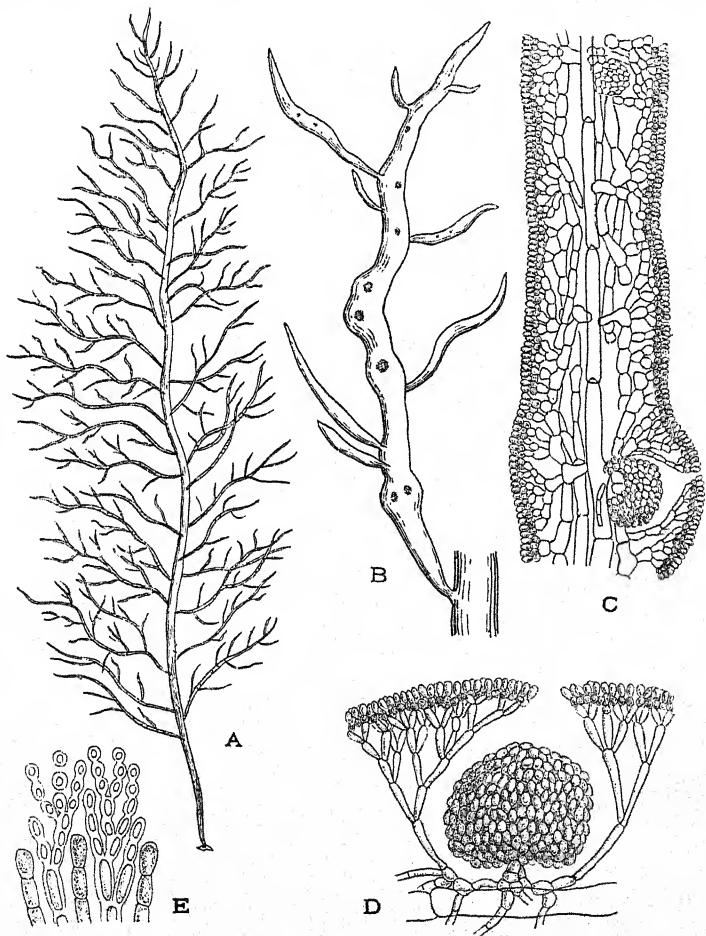


Fig. 165.—*Gloiosiphonia capillaris* Carm. A. ($\times \frac{3}{4}$); B. Portion bearing cystocarps ($\times 35$); C. Section of thallus with cystocarp ($\times 100$) (after Bornet); D. Cystocarp ($\times 200$); E. Antheridia ($\times 300$).

GLOIOSIPHONIA Carm.(Gr. *gloios*, viscid, and *siphon*, a tube.)

Frond gelatinous, tubular, cylindrical, attenuate at the extremities, formed of a peripheral zone of longitudinally elongated interwoven cells, bounded externally by a layer of short, horizontal, branched, moniliform filaments. Cystoc. attached to the base of the moniliform filaments, spherical; tetrasporang. cruciate, at the summit of the cortical filaments.

G. capillaris Carm.—Several fronds arising from the same base, clear rosy-crimson, tender, gelatinous and slippery, 7.5–30 cm. long, cylindrical, with conspicuous main axes, each attenuate at base and apex, naked below, clothed above with lateral branches, bearing several series of branchlets and numerous small setaceous ramuli. Outline of the frond ovate-oblong, rather bushy; branches and ramuli all attenuate at the extremities. Frond tubular, particularly in the older parts. Cystoc. consisting of branched, sporogenous, radiating filaments, without pseudoparenchymatous wall; frequently forming small protuberances on the filaments; antherid. terminal on the cortical filaments; tetrasp. on the cortical filaments.

On rocks, in pools near low-water mark; frequently cast ashore. Occurrence uncertain, abundant at irregular intervals in some localities; widely distributed.

Family II.—GRATELOUPIACEÆ

Thallus differentiated into a denser cortex and a laxer filamentous medulla. No procarp present; carpogonium and auxiliary organ developed in separate branched structures originating from the inner cortical cells. Cystocarp opening by a pore, tetrasporang cruciately divided.

1. **GRATELOUPIA** C. A. Agardh

(After J. P. F. Grateloup, a French botanist.)

Thallus compressed, dichotomous or primately branched, often proliferous from the margin or from the surface of the thallus, fleshy, gelatinous, composed of a central tissue of small elongated anastomosing filaments, bounded on the outside by a zone of dichotomous, moniliform cells, arranged at right angles to the surface, diminishing in size towards the exterior. Cystoc. sunk in the thallus or forming small protuberances; tetrasporang. borne between the outer moniliform cells, cruciate.

Key.

- | | |
|--------------------------------------------------------------------------------------------|--------------------------|
| 1. Thallus simple or dichotomously branched | 2. |
| Thallus pinnately branched | <i>G. filicina</i> (1). |
| 2. Thallus simple | 3. |
| Thallus dichotomous | 4. |
| 3. Frond 1-2 cm. long; on rocks at extreme low water..... | <i>G. minima</i> (3). |
| Frond 5-12 cm. long; where fresh water runs into the sea | <i>G. filicina</i> (1). |
| 4. Thallus 3-7 cm. long; fastigiate at the tips; where fresh water runs into the sea | <i>G. dichotoma</i> (2). |
| Thallus 1-2 cm. long; on rocks at extreme low-water mark | <i>G. minima</i> (3). |

1. *G. filicina* C. A. Agardh. Lat. *filicinus*, fern-like.—Plants dark violet or blackish green, tufted, 5-12 cm. long; thallus linear, attenuate at each extremity, 1-4 mm. broad, rarely simple, usually pinnately branched, the branches sometimes bearing a second series of pinnate branchlets; branches and

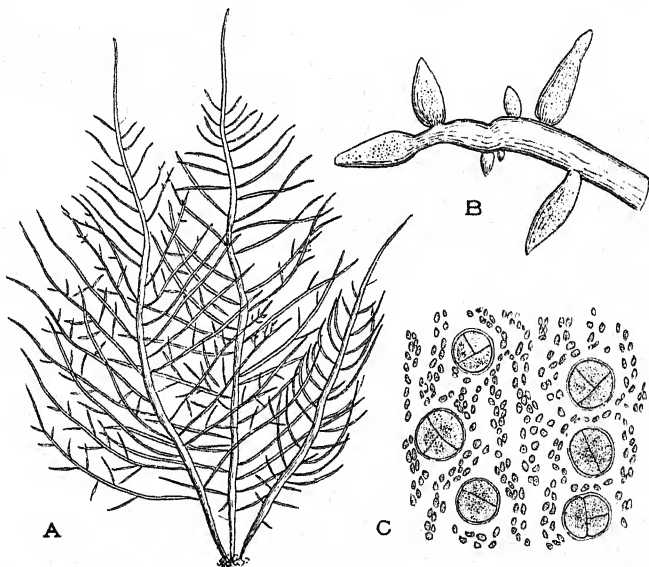


Fig. 166.—*Grateloupia filicina* C. A. Agardh. A. ($\times \frac{2}{3}$); B. Portion ($\times 9$); C. Surface view of tetraspores ($\times 300$).

branchlets sometimes irregular or unilateral in arrangement, always attenuate at base and apex. Tetrasporang. oval, cruciate, formed in the moniliform cells of the outer layer.

On rocks where fresh water runs into the sea. Rare; Wales, Somerset, S. England and Channel Islands.

2. *G. dichotoma* J. G. Agardh. — Thallus violet-purple, compressed linear, 3–7 cm. long; gregarious, simple below, dichotomous above, fastigiate; apices unequal, sub-palmate; segments linear, patent or somewhat erect, about 2 mm. broad, attenuate upwards. Cystoc. in groups, 4–6 together, in the middle and upper segments; tetrasp. in the outer layers.

On rocks where fresh water runs into the sea. Rare; Somerset, Cornwall and Devon.

3. *G. minima* Crouan. Lat. *minimus*, least. — Frond violet-purple, 1–2 cm. long, simple or branched, somewhat incurved, compressed, lanceolate, attenuate at the apex or obtuse. Cystoc. in the swollen apices of the frond.

On rocks at extreme low water. Very rare; Devon.

2. **HALYMENIA** C. A. Agardh

(Gr. *hals*, the sea, and *humen*, a membrane.)

Thallus terete, compressed, or flat, variously branched, gelatinous or fleshy, consisting of branched, elongated, anastomosing filaments in the centre, bounded by a zone of roundish or oval cells, smallest near the periphery. Cystoc. in the outer layers of thallus; tetrasporang. scattered in the outer layers, cruciate.

H. latifolia Crouan. Lat. *latus*, broad; *folium*, leaf. — Thallus flat, simple, 15–40 cm. long, 4–12 cm. broad, firm, very much attenuate at the base, attached by a small disc to corallines.

Very rare, obtained only by dredging; Co. Antrim.

Family III.—DUMONTIACEÆ

Thallus with terminal cell growth. Procarp absent. Carpgonium and auxiliary cell occurring on specifically developed, separate, multicellular branches. Gonimoblast entirely enclosed in loose thallus tissue. Pericarp and ostiole absent.

1. **DUMONTIA** Lamour.

(After G. L. M. Dumont de Courset, French botanist.)

Thallus cylindrical or compressed, irregularly branched, gelatinous, membranaceous; central axis bearing lateral branches which may themselves bear similar branchlets, attenuate at their extremities, tubular, at least in the lower parts, formed of a peripheral layer of elongated anastomosing filaments, bounded by a limiting layer of smaller cells, arranged in radial rows. Cystoc. numerous, small on the inner side of the outer layers; tetrasporang. cruciate, scattered in the cortical layer: on separate individuals.

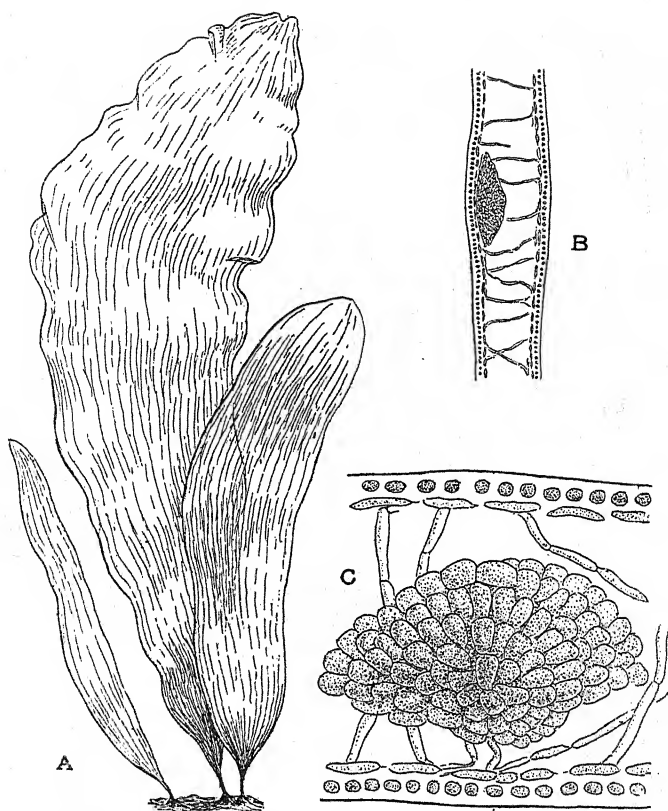


Fig. 167.—*Halymenia latifolia* Crouan. A. ($\times \frac{1}{4}$); B. Section of thallus with cystocarp ($\times 60$); C. Cystocarp ($\times 300$).

D. incrassata Lamour. (*Dumontia filiformis* Grev.). Lat. *incrassatus*, thickened.—Fronds varying in colour from pale yellowish to dull purple, membranaceous, gelatinous within; solitary or tufted, 2.5–50 cm. long, cylindrical or compressed, tubular, with a conspicuous main axis bearing alternate or irregularly placed lateral branches, which may themselves bear similar branchlets; axis and branches attenuate below, gradually attenuate above, more or less waved, flexuous, usually unequally distended. Cystoc. abundant in summer, on the inner side of the tubular thallus; tetrasp. borne in the outer layers.

On rocks and stones at about half-tide level. Common; widely distributed.

var. **crispata** Batt.—Frond broad, compressed, waved, curled and twisted. In places exposed to tidal currents. Not uncommon; widely distributed.

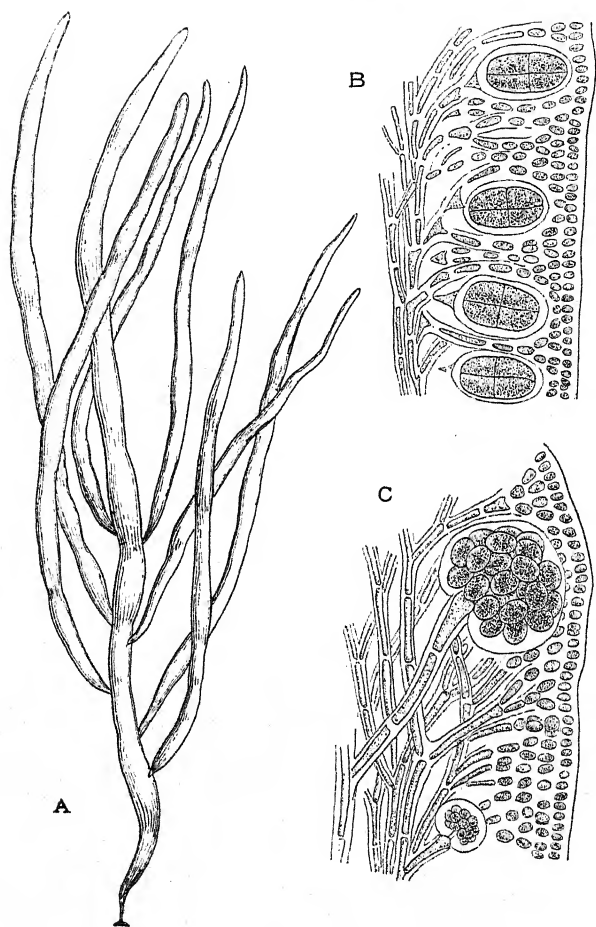


Fig. 168.—*Dumontia incrassata* Lam. A. ($\times \frac{3}{8}$); B. Longit. sect. of portion of thallus bearing tetraspores ($\times 170$); C. Longit. sect. of portion bearing cystocarps ($\times 170$).

2. DUDRESNAYA Bonnem.

(After Dudresnay de St. Pol de Leon, French soldier and collector.)

Thallus cylindrical, much branched, gelatinous, soft, consisting when young of a simple, articulated filamentous axis, bearing whorls of dichotomous ramuli; when older formed of a polysiphonous central filament and densely set whorls of ramuli.

Cystoc. near the base of the horizontal ramuli, small, oval; tetrasporang. oval, zonate.

D. verticillata Le Jol. (*D. coccinea* Crouan).—Fronds crimson, gelatinous, from 15–25 cm. long, much branched and bushy,

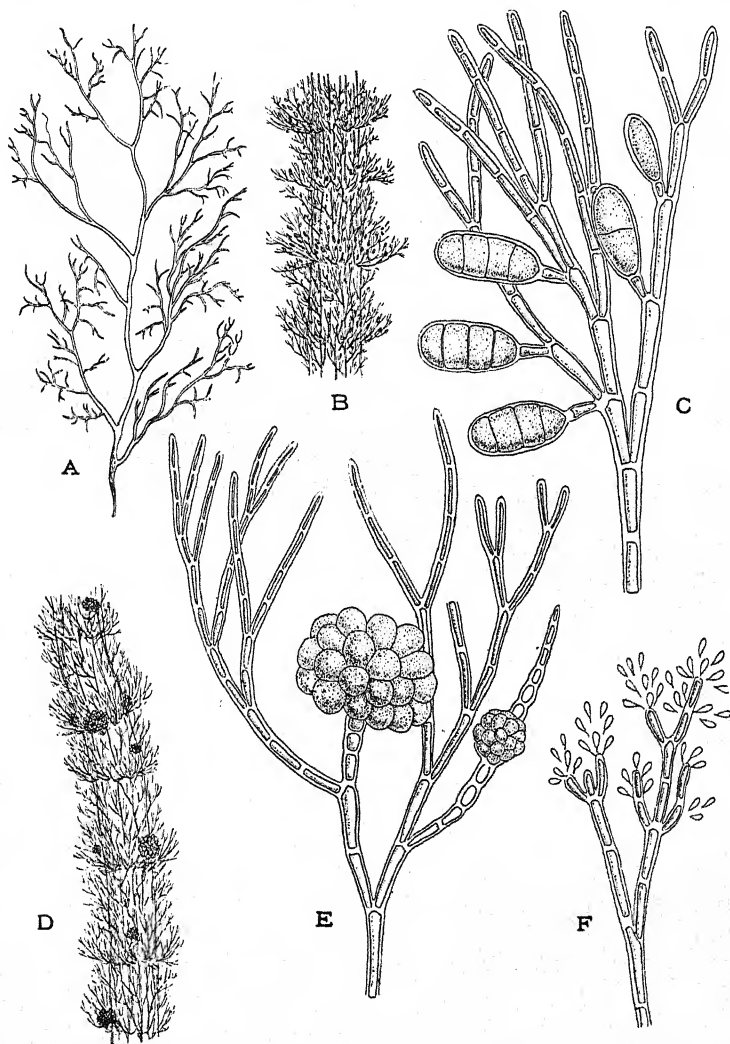


Fig. 169.—*Dudresnaya verticillata* Le Jolis. A. ($\times \frac{3}{2}$); B. Portion bearing tetraspores ($\times 33$); C. Zonate tetraspores ($\times 300$); D. Portion bearing cystocarps ($\times 33$); E. Cystocarps ($\times 300$); F. Filaments bearing antheridia ($\times 430$).

with a conspicuous central axis closely set with lateral branches or divided near the base into several axes, set with alternate patent branches, the longest below; branches bearing 2, 3 or 4 series of branchlets, either dense or sparse; branches appearing moniliform in young plants, cylindrical in older ones, owing to the more densely packed whorls of ramuli, which are many times dichotomous; cells somewhat clavate, much smaller than the axis. Cystoc. oval, attached to the base of the ramuli; antherid. on the tips of the ramuli; tetrasporang. terminal on the horizontal ramuli.

On rocks near low-water mark or in deeper water. Rare; widely distributed.

3. *DILSEA* Stackh.

(From *Dils*, the Gaelic name of an edible alga.)

Thallus flat, leafy, markedly attenuate below, composed of a thick central portion formed of elongated anastomosing filaments, and a dense outer layer formed of moniliform dichotomous filaments, perpendicular to the surface. Cystoc. spherical, formed in the medullary tissue; tetrasporang. oval, cruciate, formed at the base of the peripheral layer.

D. edulis Stackh. (*Īridæa edulis* Harv.). Lat *edulis*, edible.—Numerous fronds arising from the same base, dark red, cartilaginous, somewhat fleshy, 15–30 cm. or more in length, 5–15 cm. broad in the widest part, very much attenuate below, expanding above into a flat, simple, obovate frond, obtuse and rounded at the apex, usually split, eroded or covered with marine animals. Cystoc. in the medullary tissue, visible as dark spots on the frond; antherid. on the outermost cells; tetrasporang. at the base of the peripheral layer, in an almost continuous band.

On rocks near low-water mark. Common; widely distributed.

This plant is far from variable in form, but was for many years confused with *Rhodymenia palmata*, which is edible and forms the "Dulse" of Scotland and Ireland. It is said to have been eaten by Cornish fishermen, but has not been as much in favour as the more membranaceous Dulse. The fronds impart a pink colour to fresh water in common with *Rhodymenia palmata*, *Calliblepharis jubata* and other algæ with broad flat fronds. It is possible that the rouge used by the ladies of ancient Greece and Rome was obtained from this species, as suggested by Batters ("Marine Alga of Berwick-on-Tweed"). The word *Fucus* came into use in England to designate cosmetic pigments in general, and is frequently used by Elizabethan dramatists:

"*Liv.* How do I look to-day?

Eud. Excellent clear, believe it. This same fucus was well laid on."

BEN JONSON, *Sejanus*, II. 1.

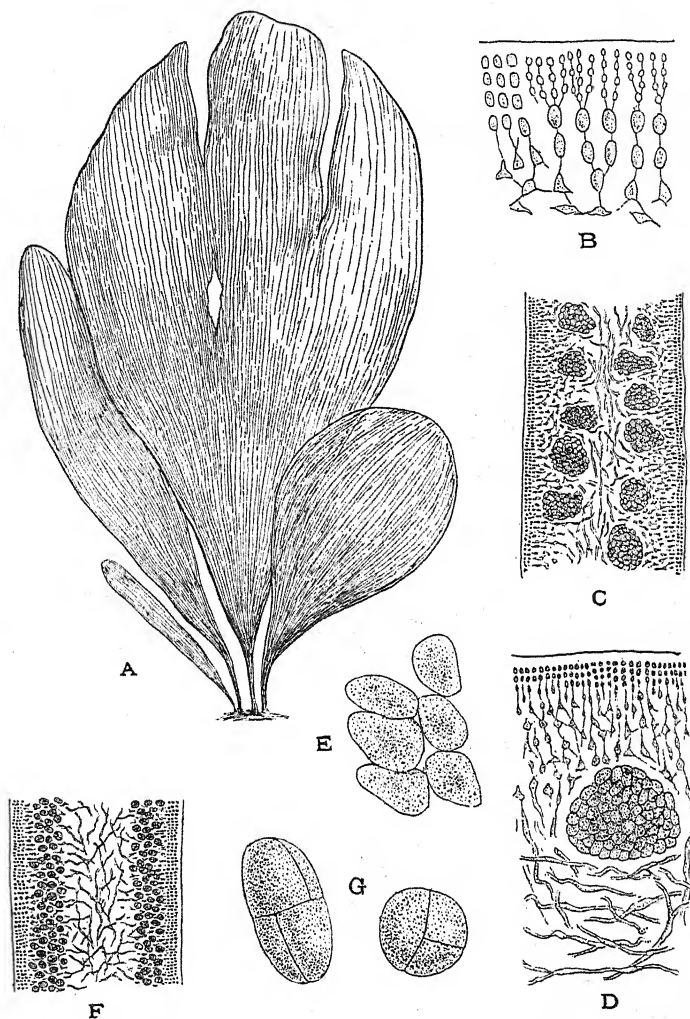


Fig. 170.—*Dilsea edulis* Stackh. A. ($\times 13$); B. Longit. sect. showing antheridia ($\times 300$); C Longit. sect. showing cystocarps ($\times 33$); D. Cystocarp ($\times 100$); E. Carpospores ($\times 300$); F. Longit. sect. showing tetraspores ($\times 33$); G. Tetraspores ($\times 300$).

Family IV.—NEMASTOMACEÆ

Procarp absent, primitive carpogonial branch outwardly directed, normally generated vegetative cell assuming the function of an auxiliary cell.

1. **CALOSIPHONIA** Crouan(Gr. *kalos*, beautiful, and *siphon*, a tube.)

Frond almost cylindrical, branched, monosiphonous in the centre, each articulation bearing a median whorl of 4 cells, cruciately placed, from which dichotomous filaments extend to the periphery, diminishing in size centrifugally, traversed

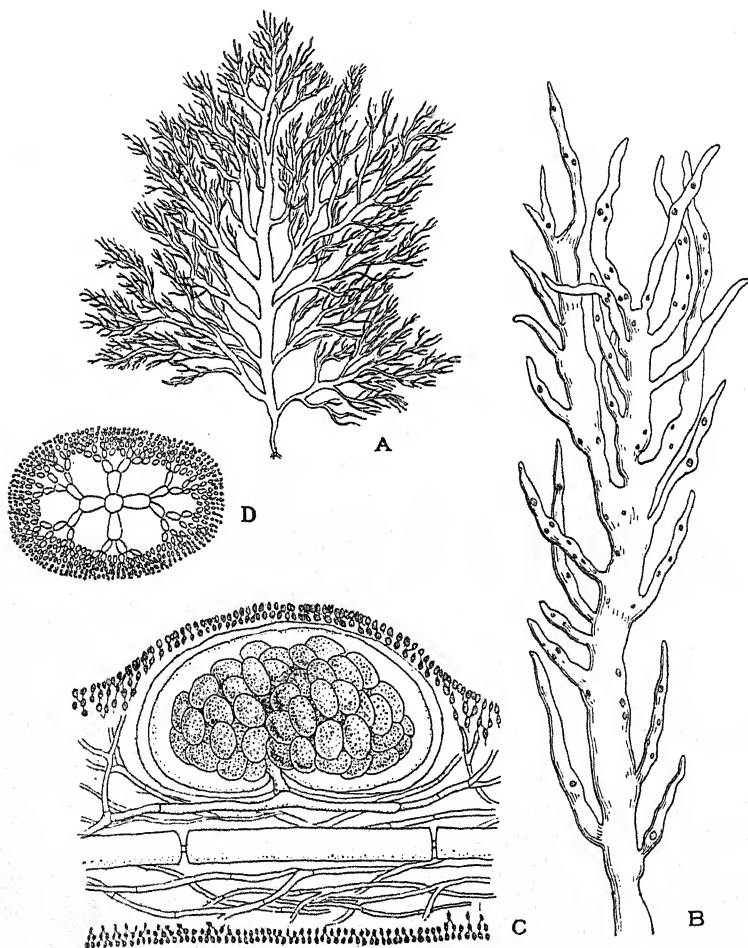


Fig. 171.—*Calosiphonia vermicularis* Schmitz. A. Plant ($\times \frac{2}{3}$); B. Portion of thallus with cystocarps ($\times 33$); C. Trans. sect. of thallus with cystocarp ($\times 300$); D. Trans. sect. of thallus showing median whorl of four cells arising from the central siphon ($\times 150$).

at intervals by longitudinal anastomosing filaments. Thallus bounded externally by a pseudoparenchymatous layer of small closely packed moniliform cells. Cystoc. spherical, at the base of the outer pseudoparenchymatous layer.

C. vermicularis Schmitz (*C. finisterræ* Crouan). Lat. *vermicula*, a little worm.—Disc-like attachment from which arises an almost cylindrical, alternately branched, rose-red, gelatinous, slippery frond, 3–8 cm. in length; branches sometimes bearing a second series of branchlets; articulations visible, but not very sharply marked; branches of all series alternate at the apices. Cystoc. at the base of the outer layer, in the branches.

Usually in deep water. Very rare; Dorset and Channel Islands.

2. SCHIZYMENIA J. G. Agardh

(Gr. *schizo*, to divide, and *hymen*, a membrane.)

Thallus flat, leafy, sessile or shortly stalked, more or less gelatinous, entire or irregularly lobed, consisting of a central portion of somewhat elongated anastomosing filaments, and a limiting layer of small cells arranged in rows perpendicular to the surface. Cystoc. spherical, in large numbers in the outer part of the central medullary tissue; tetrasporang. zonate, in the outer layers.

S. Dubyi J. G. Agardh (*Kallymenia Dubyi* Harv.). After J. E. Duby, French botanist.—Attached by a small disc, shortly stipitate, soon expanding into a full, deep red, membranaceous leafy frond which pales, thickens, and becomes more cartilaginous with age, 15–30 cm. long, 7.5–12.5 cm. broad, oblong, more or less obovate, somewhat undulate at the margin, simple, obtuse, tapering below. Cystoc. appearing as minute spots in the frond, in the central tissue near the dense cortical layer.

On rocks and stones, between the tide-marks, in land-locked bays. Very local; Ireland. Cornwall, Devon and Channel Islands.

3. PLATOMA Schmitz

(? Gr. *plate*, oar-blade.)

Frond more or less compressed, dichotomous or irregularly branched, sometimes proliferous from the margin, fleshy, gelatinous. Centre of the thallus formed of narrow elongated cells, cortical layer formed of anticlinal rows of cells becoming progressively smaller towards the exterior of the thallus. Cystoc. small, formed in the cortical layer, spores escaping through an ostiole; tetrasp. cruciate.

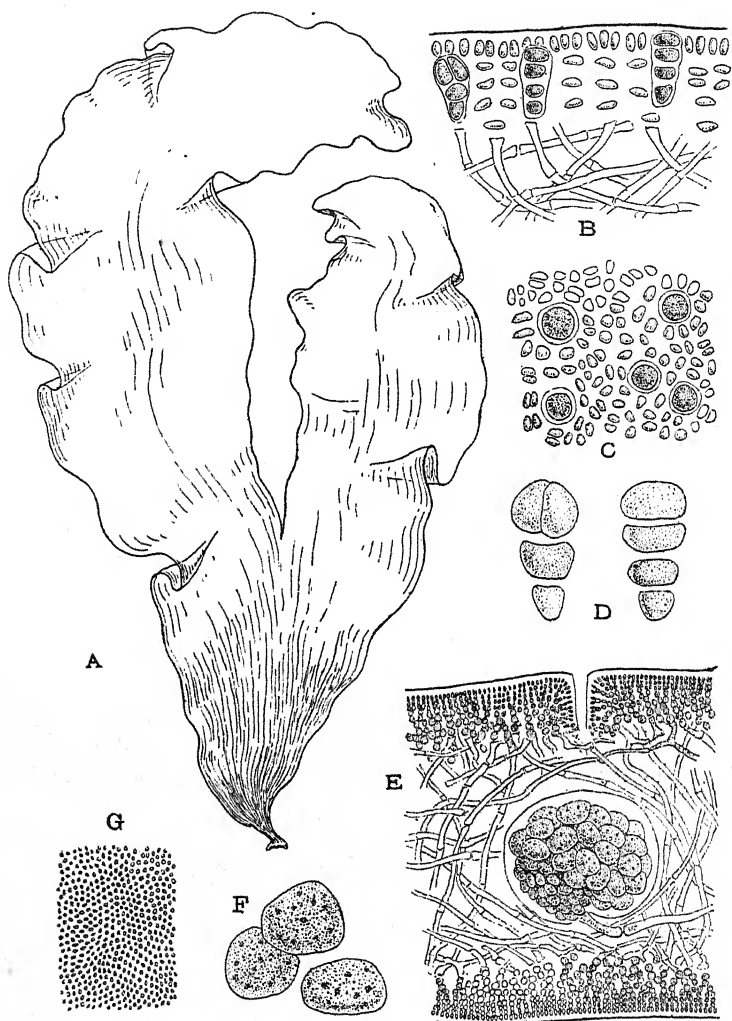


Fig. 172.—*Schizymenia Dubyi* J. G. Agardh. A. ($\times \frac{3}{2}$); B. Trans. sect. showing tetraspores ($\times 30$); C. Surface view showing tetraspores ($\times 300$); D. Individual tetraspores ($\times 600$); E. Trans. sect. showing cystocarp ($\times 200$); F. Carpospores ($\times 300$); G. Surface of cystocarpic thallus ($\times 200$).

Key.

- Plants as much as 25 cm. long, marginal proliferations from 3-5 cm. long..... *P. marginifera*
 Plants small and slender, scarcely more than 2.5 cm. long, vermiform *P. Bairdii*

P. marginifera J. G. Agardh.—FronD bright red, fleshy, gelatinous, monœcious, flat, divisions lanceolate or cuneate, margin often proliferous. As much as 25 cm. long, often con-

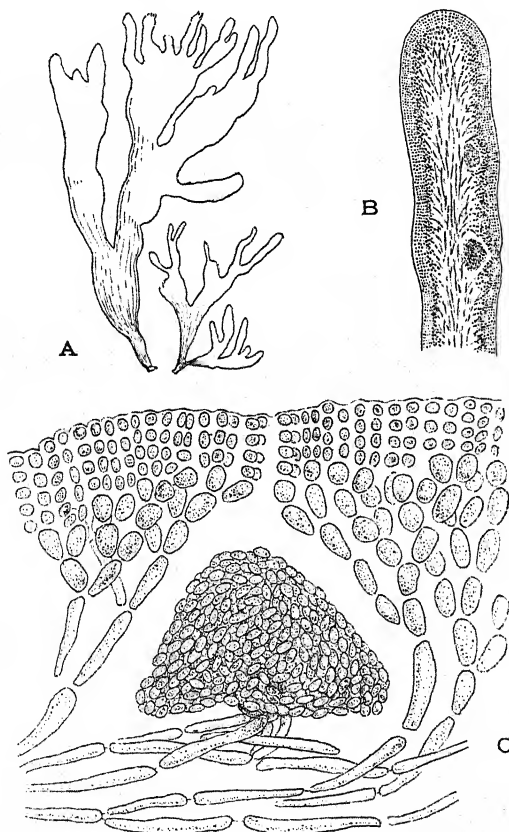


Fig. 173.—*Platoma marginifera* J. G. Agardh. A. ($\times \frac{1}{2}$); B. Trans. sect. of thallus with cystocarps ($\times 33$); C. Cystocarp ($\times 300$).

siderably shorter, attached by small disc, 22-24 mm. broad in the centre, attenuate at the apex, entire or cut into segments, subdichotomous; marginal proliferations 3-5 cm. long, attenuate at each extremity.

Very rare; Cornwall.

P. Bairdii Kuckuck (*Helminthocladia Hudsoni* Batt., non J. G. Agardh). After Prof. Baird of the United States Fish Commission.—Fronds purplish red, gelatinous, about 10 cm.

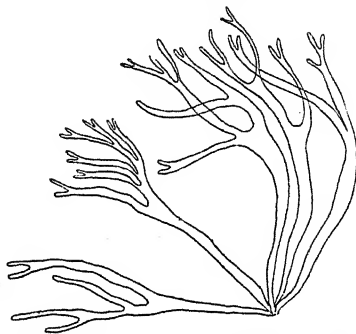


Fig. 174.—*Platoma Bairdii* Kuckuck.

long, 2.5 cm. broad at the base, vermiform, once or twice dichotomously branched, axils acute, apices attenuate. Tetrasp. on the tips of the peripheral filaments.

Very rare ; Northumberland.

4. **HALARACHNION** Schmitz

(Gr. *hals*, the sea, and *arachne*, a spider.)

Thallus compressed or flat, entire or divided, often proliferous, consisting of a thin cortical layer of small compact cells, the whole of the central portion being traversed by thin filamentous strands, widely spread. Cystoc. spherical, on the inner side of the cortical layer ; antherid. in the outermost cells.

H. ligulatum Kütz. (*Halymenia ligulata* C. A. Agardh, var. *genuinum* Hauck). Lat. *ligulatus*, strap-shaped.—Thallus usually 10–30 cm. long, flat, ribbon-like, 0.5–4 or even 10 cm. broad, usually very proliferous.

Rare ; mostly confined to S. England and S. Ireland.

var. **dichotomum** Harv.—Fronde 15–20 cm. long, very narrow, compressed, many times irregularly dichotomous, the divisions of nearly equal breadth, gradually narrower towards the acuminate extremities. Not uncommon ; Padstow, Yarmouth and Jersey.

var. **latifolium** Harv.—Deep red, 30–50 cm. long, 5–10 cm. wide, flat, stipitate, wedge-shaped, simple, forked or irregularly palmate. Rare ; S. England, Kirkwall, and W. Ireland.

var. **ramentaceum** Harv.—30–35 cm. long or more, 1.75 cm. broad, compressed, gelatinous, divided into 3 or 4 main branches bearing simple or occasionally forked branchlets, constricted

below, attenuate above, cylindrical or nearly so. Sidmouth and Brighton.

var. **aciculare** Hauck.—Thallus 5–10 cm. long, terete or flattened, lower half 1–3 mm. thick, upper segments as little as 400μ thick. Rare; S. England, Kirkwall, and Channel Islands.

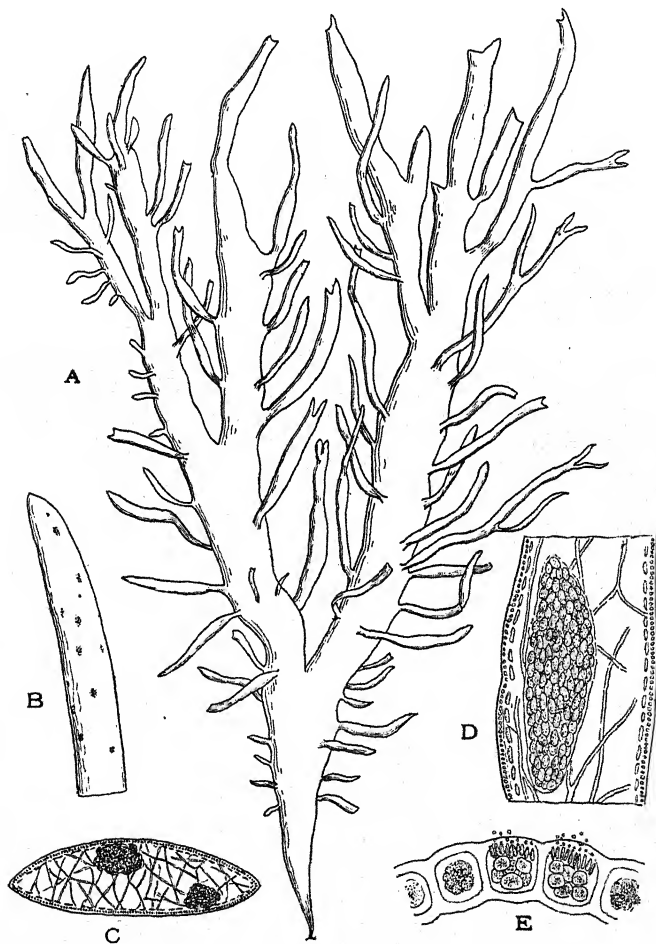


Fig. 175.—*Halarachnion ligulatum* Kütz. A. ($\times \frac{1}{2}$); B. Portion of cystocarpic thallus ($\times 6$); C. Trans. sect. of same ($\times 33$); D. Cystocarp ($\times 150$); E. Antheridia ($\times 600$).

5. **FURCELLARIA** Lamour.(Lat. *furcula*, a little fork.)

Fronds attached by branching rhizoids, cylindrical, repeatedly dichotomous, solid, cartilaginous, ultimate pairs of branches attenuate at their apices; consisting of a medullary central portion formed of elongated anastomosing filaments, and a

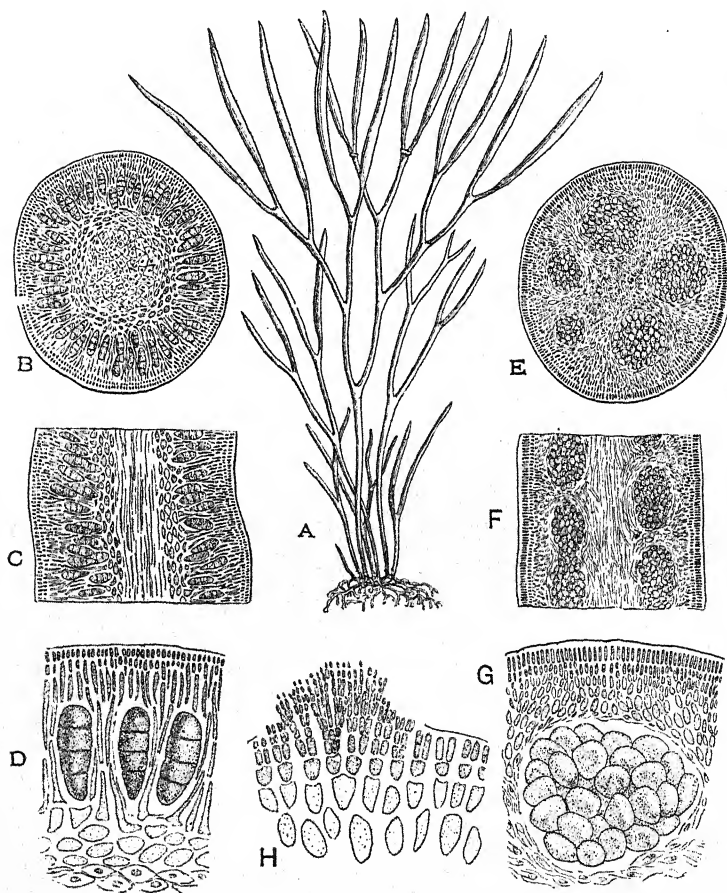


Fig. 176.—*Furcellaria fastigiata* Lamour. A. ($\times \frac{1}{4}$); B. Trans. sect. of tetrasporic thallus ($\times 33$); C. Longit. sect. of same ($\times 33$); D. Portion of same ($\times 90$); E. Trans. sect. of cystocarpic thallus ($\times 33$); F. Longit. sect. of same ($\times 33$); G. Cystocarp ($\times 90$); H. Antheridia ($\times 416$).

wide band of cortical tissue, the latter consisting on the inside of roundish or oval cells, loosely packed, on the outside of compact rows of dichotomous filaments arising from a zone of elongated ellipsoidal cells, arranged at right angles to the surface. Cystoc. and tetrasporang. in siliculose terminal ramuli; cystoc. globose, in the inner cortical tissue; tetrasporang. zonate, pyriform, elongated, in the inner cortical tissue; antherid. borne on the surface of the frond arising from the outer layers.

F. fastigiata Lamour.—Fronds dark brownish red, gelatinous, arising from tangled branching rhizoids, densely tufted, 10–20 cm. long, filiform, cylindrical, undivided near the base, many times regularly dichotomous above, angles acute, apices of the branches of equal length, lanceolate, tapering to a fine point; ultimate ramuli fertile, shed annually. Plants dioecious.

Common; widely distributed.

Distinguishable from *Polyides rotundus* by the smaller angle of the branches, and the form of the attachment organ, branched attachment rhizoids replacing the compact disc of *Polyides*.

Family V.—RHIZOPHYLLIDACEÆ

Differing from the Dumontiaceæ by the concentration of the reproductive organs into nemathecium. Tetrasporang. cruciately divided.

POLYIDES C. A. Agardh

(Gr. *polus*, many, and *idios*, the same.)

Plants dioecious, attached by a basal disc; fronds cylindrical, dichotomous, solid, cartilaginous, consisting of a central medullary tissue formed of longitudinally elongated and anastomosing filaments, and a wide band of cortical tissue, the inner part formed of oval loosely-packed cells, the outer of closely-packed cells in transverse series, becoming smaller centrifugally. Cystoc. and antherid. forming swollen spots on the branches; tetrasporang. cruciate, immersed among the peripheral filaments.

P. rotundus Grev.—Fronds densely tufted, dark brownish red, cartilaginous, 10–20 cm. long, attached by a flattened disc, 1.75 cm. or more diam., cylindrical, undivided at the base, many times dichotomous above, the axils rounded; apices somewhat attenuate, of equal length. Cystoc. and antherid. forming wart-like protuberances on the branches, oval or cylindrical; tetrasp. in the upper branches, deeply sunk.

On rocks in pools, between the tide-marks, perennial.
Common; widely distributed.

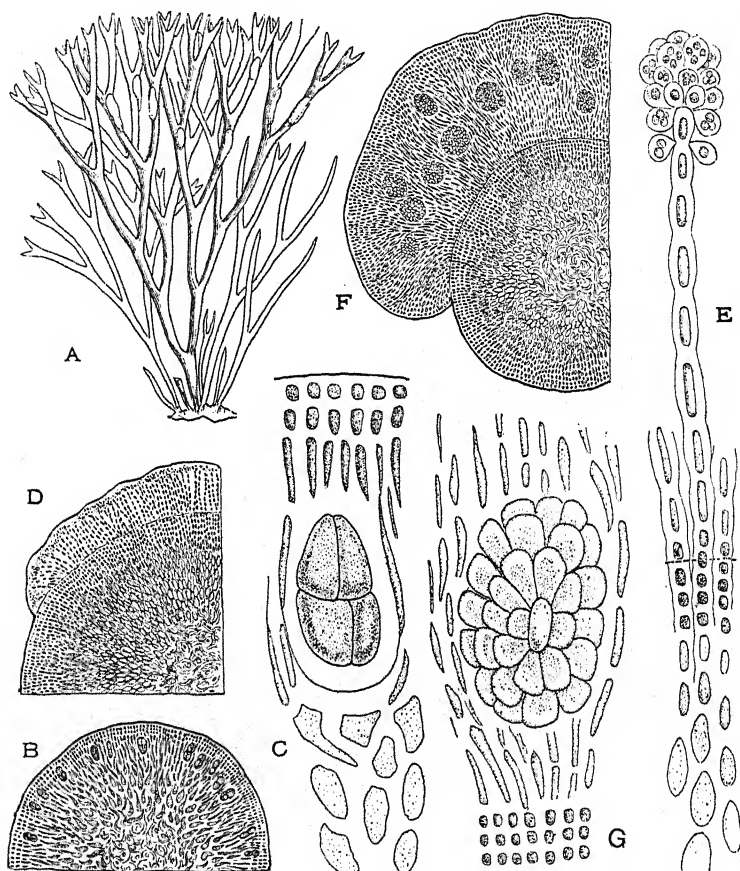


Fig. 177.—*Polyides rotundus* Grev. A. showing nemathecia ($\times 1$); B. Trans. sect. of tetrasporic thallus ($\times 33$); C. Portion of same ($\times 300$); D. Trans. sect. of antheridial thallus ($\times 33$); E. Portion of same showing antheridia ($\times 300$); F. Trans. sect. cystocarpic thallus ($\times 33$); G. Cystocarp ($\times 300$).

Family VI.—SQUAMARIACEÆ

Growth by a single apical cell. Carpogonial branch and auxiliary branch separated from one another; procarp absent. Tetrasporang. cruciate.

1. RHODODISCUS Crouan

(Gk. *rhodos*, red, and *diskos*, disc.)

Thallus flat, encrusting margin lobed, attached by the under surface; rhizoids absent; basal layer formed from a series of cells united into a pseudoparenchymatous tissue; erect filaments loosely coalescent. Cystoc. unknown; tetrasp.

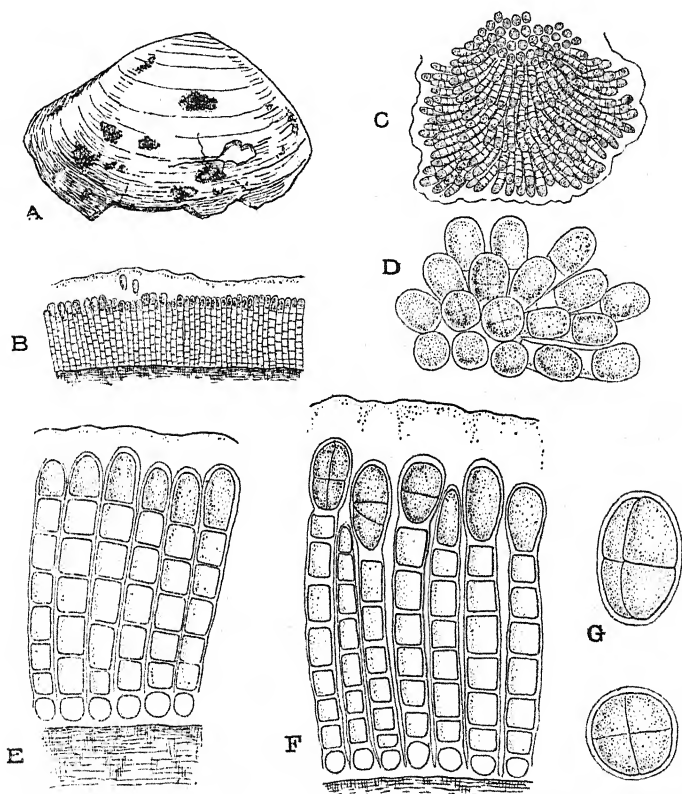


Fig. 178.—*Rhododiscus pulcherrimus* Crouan. A. Growing on shell ($\times 3$); B. Trans. sect. of thallus ($\times 60$); C. Surface view ($\times 80$); D. Same showing tetraspores ($\times 416$); E. Trans. sect. of thallus ($\times 416$); F. Same with tetraspores ($\times 416$); G. Tetraspores ($\times 600$).

in irregular sori on the surface of the frond; tetrasporang. cruciate, paraphyses absent.

R. pulcherrimus Crouan. Lat. *pulcherrimus*, most beautiful.—Frond rose-red, disc-like or irregular, 3–8 mm. diam.,

thin, slightly thickened in the centre, margin lobed or laciniate, erect filaments radially placed. Tetrasporang. obovate in terminal cells of vertical filaments.

On shells and fragments of pottery. Obtained only by dredging. Very rare; Devon.

2. *PETROCELIS* J. G. Agardh

(Gr. *petros*, a stone, and *kelis*, a stain.)

Thallus horizontally expanded, more or less gelatinous and coriaceous, adhering closely to the substratum; vertical filaments united below, held together above by a gelatinous substance. Cystoc. on the vertical filaments, elongated or irregularly lobed; tetrasporang. cruciate or irregularly divided, spherical, intercalary in the erect filaments.

Key.

One tetrasporang. in a single filament *P. cruenta*,
Six, eight or more tetrasporang. in a single filament .. *P. Hennedyi*.

P. cruenta J. G. Agardh (*Cruoria pellita* Harv., non Lyngb.). Lat. *cruentus*, blood red.—Forming smooth, glossy,

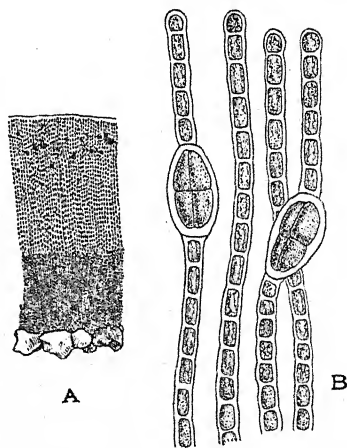


Fig. 179.—*Petrocelis cruenta* J. G. Agardh. A. Section of thallus ($\times 28$); B. Single filaments with tetraspores ($\times 400$).

brownish red patches, circular or lobed, tenacious, very elastic, 0.5–1 mm. thick, composed of vertical filaments united in a gelatinous substance; articulations about as long as broad. Tetrasporang. solitary, intercalary in the vertical filaments.

Spreading over the surface of bare rocks, between the tide-marks. Not uncommon; widely distributed.

P. Hennedyi Batt. (*Actinococcus Hennedyi* Harv.).

After R. Hennessey, Scottish botanist.—Forming glossy, fleshy dark purple patches, composed of simple, vertical, parallel filaments, firmly united below, but held loosely together above by a gelatinous substance. Cytoc. composed of small spores placed one above the other in one or more rows on the vertical filaments; tetrasporang. large, cruciate, subquadrate, 6, 8, or 12 formed in successive cells of the filament.

On the stipes of *Laminaria hyperborea*. Common; Scotland and N. England.

3. CRUORIA Fries

(Lat. *cruor*, blood.)

Thallus encrusting, attached to the substratum by its underside, fleshy, gelatinous, formed of simple or branched, vertical, erect, parallel filaments arising from a basal layer. Cystoc. on the vertical filaments, elongated, spindle-shaped or irregularly lobed; antherid. terminal on the erect filaments; tetrasporang. lateral, elongated, zonate.

Key.

Forming glossy dark red or purple patches on rocks or the stipes of *Laminaria hyperborea*; articulations of erect filaments $1\frac{1}{2}$ –3 times as long as broad *C. pellita*.
 Colour pale rose; only obtained by dredging; articulations of erect filaments equal in length and breadth except in the middle of the thallus *C. rosea*.

C. pellita Lyngb. (non Harv.) (incl. *C. adhærens*, J. G. Agardh). Lat. *pellitus*, having a skin.—Thallus encrusting, as much as

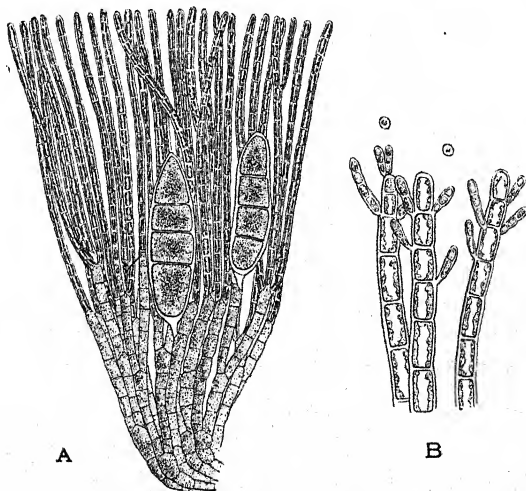


Fig. 180.—*Cruoria pellita* Lyngb. A. Trans. sect. of thallus bearing tetraspores ($\times 132$); B. Antheridia on short branchlets ($\times 360$).

0.5 mm. thick, forming glossy, dark red or purple, roundish or irregular patches; vertical filaments simple or branched, loosely united, easily separable under pressure; articulations cylindrical, $1\frac{1}{2}$ –3 times as long as broad. Cystoc. composed of a few large spores arranged in one or two rows; antherid. on short branchlets at the apices of the erect filaments; tetrasporang. large, oblong, lateral on the filaments.

On rocks or on the stipes of *Laminaria hyperborea*. Rather rare; widely distributed.

C. rosea Crouan (*C. stilla* Kuck.).—Frond 1 cm. or more in diameter, pale rose, thin, gelatinous, adhering by its under surface; basal layer formed of horizontal filaments arranged in more or less parallel rows but radiating outwards to the periphery, bifurcating several times; articulations 2–5 times as long as broad except near the margin, where they are ovoid or angular, 1–2 times their breadth; erect filaments formed of 3 or 4 articulations, as long as broad except near the middle of the thallus, where they are twice as long. Tetrasporang. elliptical or clavate, sessile, cruciate, lateral near the base of erect filaments.

Very rare; obtained only by dredging; Devon.

var. **purpurea** Batt. (*C. purpurea* Crouan).—Tetrasp. lateral near the apices of the erect filaments. Very rare; Devon.

4. CRUORIOPSIS Zanard.

(From *Cruoria* and Gr. *opsis*, appearance.)

Fronds encrusting, not calcareous, differing from *Cruoria* in the production of carpospores in chains not in a compact mass. Tetrasporang. irregularly cruciate, immersed in the substance of the frond, thallus filaments loosely united together.

Key.

Tetrasporang. lateral	<i>C. gracilis</i> .
Tetrasporang. terminal	<i>C. Hauckii</i> .

C. gracilis Batt. (*Plagiospora gracilis* Kuck.).—Thallus filaments less regularly tapering than those of *C. Hauckii*. Tetrasporang. irregularly divided, lateral on thallus filaments; tetrasp. smaller than those of *C. Hauckii*.

On old shells dredged from deep water. Very rare; Plymouth.

C. Hauckii Batt. (*Cruoriella armorica* Hauck, non Crouan). After F. Hauck, German algologist.—Fronds forming thin, purplish red encrusting expansions, closely adherent to the substratum, roundish or irregular in outline, 1–3 mm. in diameter, 50–100 μ thick, the younger fronds frequently overlapping the older ones; cells at the base of the erect filaments,

10–15 μ diam. and about as long as broad or slightly longer, gradually diminishing in breadth upwards. Tetrasporang. immersed in the substance of the frond, 24–30 μ by 15–20 μ , irregularly divided, terminal on shortened thallus filaments.

Very rare. On stones dredged from the end of the breakwater, Plymouth.

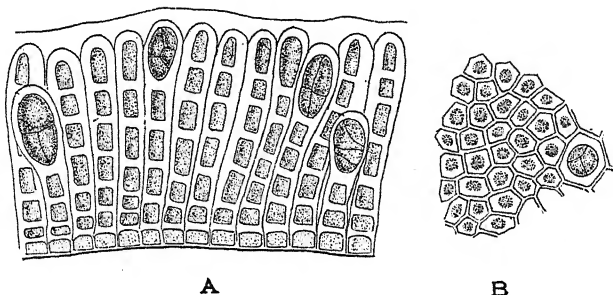


Fig. 181.—*Cruoriopsis Hauckii* Batt. A. Trans. sect. of thallus bearing tetraspores ($\times 416$); B. Surface view ($\times 400$).

5. CRUORIELLA Crouan

(From the genus *Cruoria*.)

Fronds horizontally expanded, crustaceous, adnate to the substratum below; basal cells angular, arranged in contiguous rows, forming a pseudoparenchymatous basal layer; upper filaments vertical, loosely packed, gelatinous. Cystoc., antherid., and tetrasp. in convex warts on the thallus; cystoc. consisting of a few roundish carpospores, superposed in regular rows or irregularly placed; antherid. borne on branched erect filaments, tetrasporang. on the apices of short filaments, elongated; tetrasp. cruciate.

C. Dubyi Schmitz (*Peyssonnelia Dubyi* Crouan). After J. E. Duby, French botanist.—Fronds dark red or purplish, orbicular or lobed, parenchymatous throughout; cells of the thallus a little broader than long. Cystoc. composed of a few spores placed one above the other, in one, two or three rows; paraphyses short, composed of a few cells, twice as long as broad below, much shorter above; tetrasporang. almost as long as paraphyses; tetrasp. cruciate.

On the calcareous incrustations of *Lithothamnion polymorphum* near low-water mark, and on the attachment organs of *Laminaria hyperborea*. Not uncommon; widely distributed.

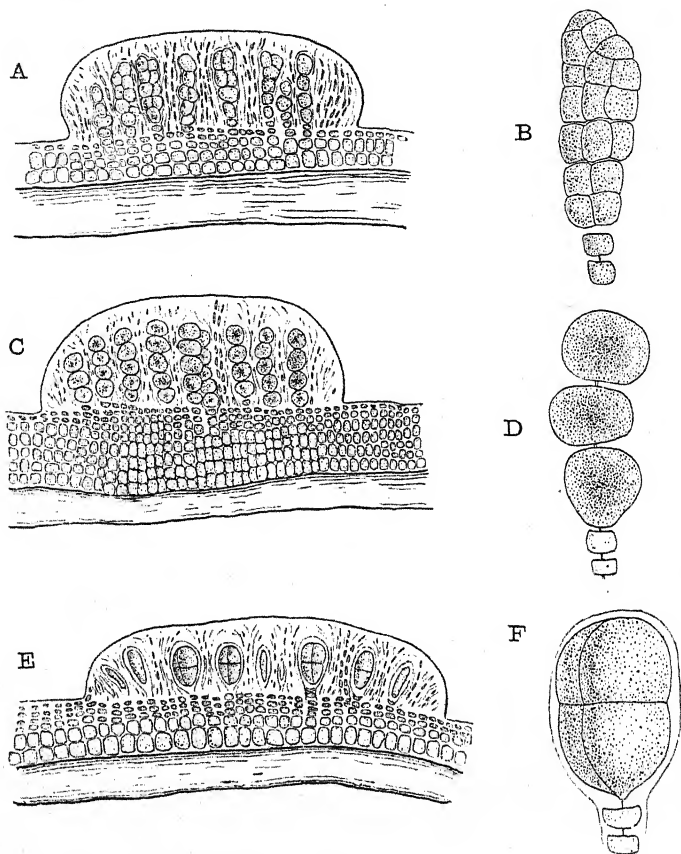


Fig. 182.—*Cruoriella Dubyi* Schmitz. A. Trans. sect. of cystocarpic nemathecium ($\times 132$); B. Carp. spores ($\times 600$); C. Young nemathecium ($\times 132$); D. Young stages in carpospore formation ($\times 600$); E. Trans. sect. of thallus bearing tetraspores ($\times 132$); F. Single tetrasporangium ($\times 600$).

6. PEYSSONNELIA Decaisne

(After J. A. Peyssonnel, French naturalist.)

Fronds horizontally expanded, sometimes somewhat calcareous, firmly attached by the lower surface, more or less lobed and divided, parenchymatous throughout; fructification in external nemathecia on the surface of the thallus, composed of slender parallel filaments on which antherid., cystoc. or tetrasporang. are borne; tetrasporang. oblong, sessile or shortly

stalked, tetrasp. cruciate; spermatia produced in the cells of the nemathecial filaments; cystoc. bearing few spores, the latter arranged in rows or on branching filaments.

Key.

- | | |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Thallus somewhat lime-encrusted | 2. |
| Thallus not calcareous | 3. |
| 2. Monostromatic layer present at the base,
from which the erect filaments arise | <i>P. Rosenvingii</i> (1). |
| Thallus composed at the base of irregular
angular cells, becoming gradually narrower
and more rectangular upwards | <i>P. Harveyana</i> (2). |
| 3. Thallus composed at the base of large cells,
from which series of oblique, then erect,
cells arise..... | <i>P. atropurpurea</i> (4). |
| Zone of obliquely-placed cells absent | 4. |
| 4. Attached by means of rhizoids | <i>P. rubra</i> (3). |
| Rhizoids absent | <i>P. rupestris</i> (5). |

1. **P. Rosenvingii** Schmitz. After L. Kolderup Rosenvinge, Danish algologist.—Thallus dark purple, crustaceous, lobed, adnate to the substratum, as much as 4 cm. diam. and 5 mm. or more in thickness, lime-encrusted beneath, except at the margin, rhizoids short, thickly covering the base; composed of a monostromatic layer, from which series of erect cells arise, subdichotomous, attenuate at the apices, forming a pseudoparenchymatous tissue; articulations 20–30 μ in breadth at the base, twice as long as broad; higher up, almost square. Nemathecia not very much swollen.

On shells and species of *Lithothamnion*. Rare; Cornwall, Devon, Dorset and Northumberland.

2. **P. Harveyana** Crouan. After W. H. Harvey, Irish algologist.—Thallus encrusting, lobed, 2–2.5 cm. diam., lime-encrusted beneath, closely adnate to the substratum; composed below of large, angular, irregular cells, becoming gradually narrower upwards, arranged in regular series; cells about twice as long as broad at the base, becoming almost square near the centre. Nemathecia ovate.

On fronds of *Cystoseira*, *Lithothamnion* and other algæ. Very rare; Cornwall, Devon and Northumberland.

3. **P. rubra** J. G. Agardh (*P. Dubyi* Harv. p. p.).—Thallus brownish or clear red, leafy, membranous, 50–160 μ thick, 2–6 cm. broad, lobed; when old, lobes superposed forming layers; lower surface clothed with short, simple rhizoids, adhering firmly to the substratum; upper surface often striate with concentric zones; frond composed of one or more basal layers, from which erect series of cells arise; cells 1½ times longer than broad below, diminishing in size upwards and becoming roundish. Nemathecia very flat.

On stipes of *Cystoseira*, *Lithothamnion*, shells, etc. Very rare; obtained by dredging from Devon and Galway.

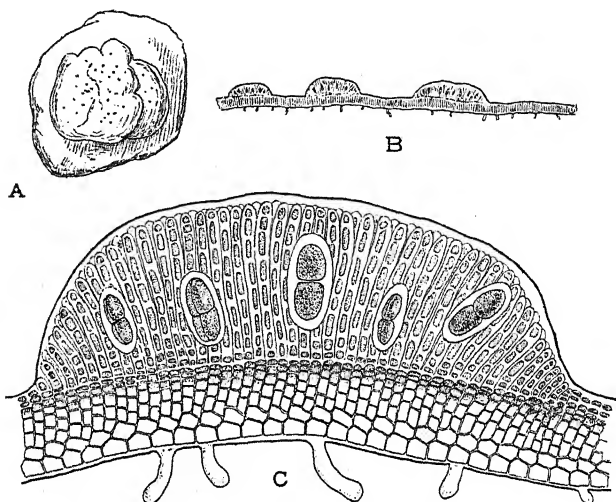


Fig. 183.—*Peyssonnelia rubra* J. G. Agardh. A. ($\times \frac{2}{3}$); B. Trans. sect. of thallus showing tetraspores and rhizoids ($\times 17$); C. Portion of same ($\times 100$).

4. *P. atropurpurea* Crouan.—Thallus purplish or brownish, 1–4 cm. in diameter, difficult to separate from the substratum, attached by lower surface and short rhizoids, consisting at the base of large cells from which series of oblique, then erect cells arise, 2–3 times longer than broad below, diminishing in length upwards. Nemathecia not much swollen, paraphyses formed of squarish cells; tetrasporang. elongated, ovate.

On rocks in shady places. Very rare; Cornwall and the Channel Islands.

5. *P. rupestris* Crouan. Lat. *rupestris*, growing among rocks.—Distinguished by thin frond, firmly adherent to the substratum, entirely destitute of rhizoids; cells of the thallus squarish throughout. Paraphyses very short, about as long as the tetraspores, slender, cells 4–5 times as long as broad.

On old shells. Very rare; obtained by dredging; Plymouth.

7. *HILDENBRANDIA* Nardo

(After Prof. F. E. Hildenbrand, Austrian botanist.)

Frond encrusting, not calcareous, thin, forming indefinite patches, composed of squarish or rounded cells arranged in

vertical rows. Tetrasporang. obliquely or irregularly divided or zonate, in round or oval conceptacles, sunk in the thallus.

Key.

- Thallus brownish, tetrasporang. slender, spindle-shaped; tetrasp. regularly zonate *H. Crouani*.
 Thallus pinkish or brownish red; tetrasporang. obliquely or irregularly divided *H. prototypus*.

H. Crouani J. G. Agardh (*H. rosea* Crouan, non Kütz.). After P. L. and H. M. Crouan, French algologists.—Frond subcoriaceous, brownish, cells more or less square, arranged in vertical rows; tetrasporang. elongated, spindle-shaped; tetrasp. regularly zonate; conceptacles large and deep.

On stones. Rare; Devon and Northumberland.

H. prototypus Nardo. Gr. *protos*, first, and *tupos*, image.—Conceptacles spheroidal; tetrasporang. irregularly divided, pyriform.

On stones and rocks near low-water mark, forming brownish or pinkish red patches. Common; widely distributed.

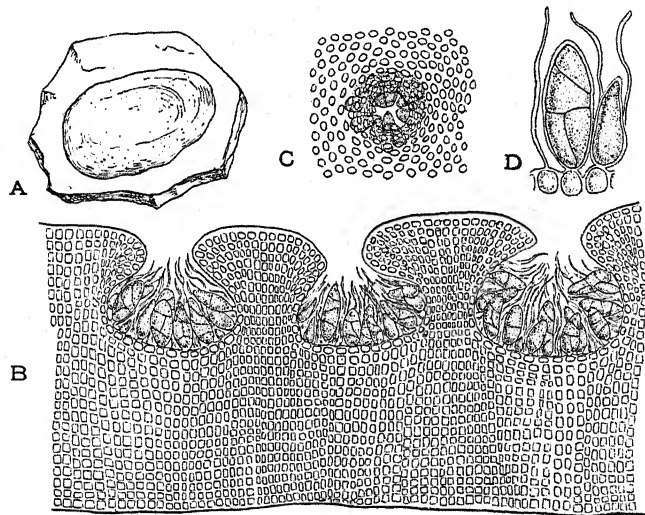


Fig. 184.—*Hildenbrandia prototypus* Nardo. A. ($\times \frac{2}{3}$); B. Section of tetrasporic thallus ($\times 300$); C. Surface view of same ($\times 300$); D. Tetraspores ($\times 600$).

Family VIII.—CORALLINACEÆ

Thallus usually very calcareous. Cystoc. pyriform or almost spherical with a terminal ostiole; tetrasporang. zonate, in sori, which frequently resemble cystoc. in shape.

1. **SCHMITZIELLA** Born. & Batt.

(After F. Schmitz, German botanist.)

Thallus consisting at first of rows of cells arranged in filaments, branching in one plane, forming a network and finally a pseudoparenchymatous expansion confined between the outer layers of the cell wall of the host; primary filaments composed

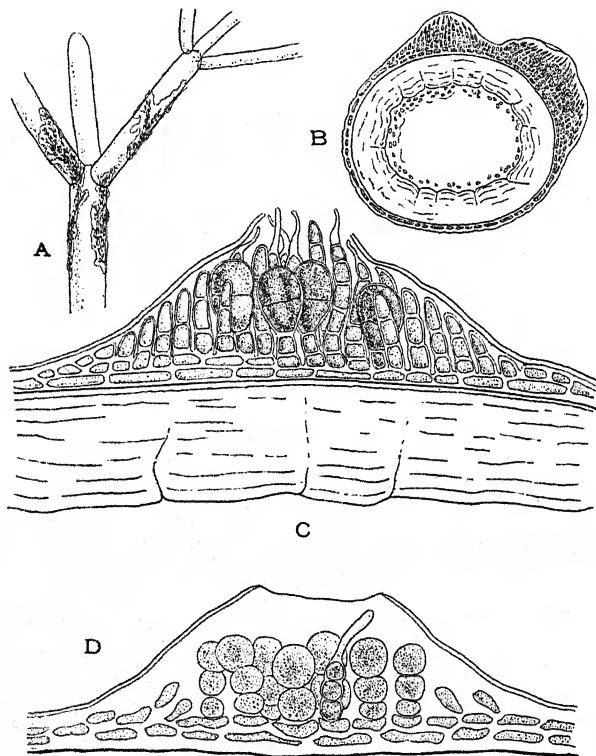


Fig. 185.—*Schmitziella endophlœa* Born. & Batt. A. Colonies on host ($\times 24$); B. Section of same ($\times 120$); C. Trans. sect. of tetrasporic nemathecium ($\times 420$); D. Trans. sect. of cystocarpic nemathecium ($\times 420$).

of elongated cylindrical cells; secondary filaments formed of short variously shaped cells arising laterally from the primary filaments. Reproductive organs developed in nemathecia, scattered over the surface of the thallus, forming flattened hemispherical protuberances; tetrasp. nemathecia rounded in

outline, central portion occupied by group of paraphyses; tetrasporang. peripheral, oval or oblong; sporang. surrounded by ring of paraphyses; cystoc. sori flattened, central portion occupied by carposp. filaments which break through the wall layers of the host, carposp. spherical; antherid. unknown.

S. endophloea Born. & Batt. Gr. *endon*, within, and *phlois*, skin.—Characters as for the genus. Tetrasporang. 20μ long, 12μ broad. In the cell-walls of *Cladophora pellucida*, giving the host a deep-red colour.

2. CHOREONEMA Schmitz

(Gr. *chorein*, to spread among, and *nema*, thread.)

Fronds endophytic, parasitic, filiform, monosiphonous, branched, calcareous. Cystoc. pedicellate, subconical, with minute apical ostiole; carposp. rounded or slightly irregular; antherid. in conceptacles, on branched filaments; tetrasporang. in similar conceptacles.

C. Thureti Schmitz (*Melobesia Thureti* Born.) After G. Thuret, French algologist.—Thallus consisting of simple or

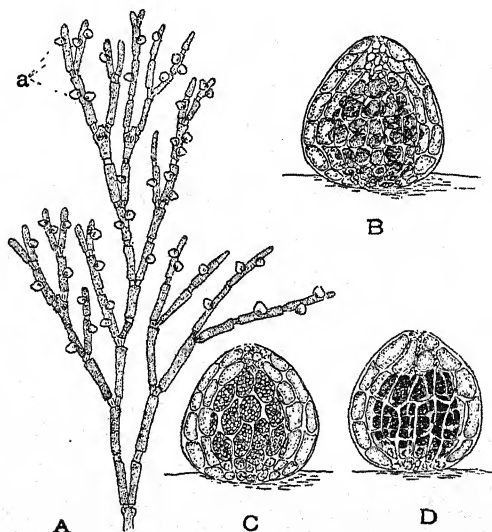


Fig. 186.—*Choremoma Thureti* Schmitz. Conceptacles (a) on *Corallina* ($\times 14$); B. Cystocarp ($\times 160$); C. Antheridial conceptacle ($\times 160$); D. Tetrasporic conceptacle ($\times 160$).

branched articulated filaments, penetrating the tissues, and bearing fructifications on the surface of the host. Conceptacles $120\text{--}140\mu$ broad, rounded or egg-shaped, pedicellate on their own

filament, sessile on the surface of the host. Parasitic on species of *Corallina*.

Not uncommon in the South of England, and said to be found all round the Irish coast.

3. MELOBESIA Foslíe

(Possibly Gr. *Melobosis*, or *Meloboia*, a daughter of Oceanus.)

Fronds calcareous, horizontally expanded, orbicular, becoming indefinite in outline, sometimes confluent. Sporang. in superficial or slightly immersed conceptacles, subconical or hemispheric-conical with a single orifice, issuing around or between a bundle of cylindrical or club-shaped paraphyses; tetrasporang. zonate, with short foot arising from an almost plain disc, which is connected with the roof by delicate filaments soon disappearing; carpospores arising round the periphery of the conjugation cell, central portion of the conceptacle bearing a bundle of short paranemata; spermatia on short filaments at the base of the male conceptacles, spherical, attenuate at one end, or bearing two short projections; swollen cells present in the vegetative thallus of some species, known as "heterocysts," though differing from those of the Nostocaceæ where the term was first employed.

Key.

- | | |
|----------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1. Thallus monostromatic, with or without solitary, small, cortical cells, except in the neighbourhood of the conceptacles | 2. |
| Thallus polystromatic | 3. |
| 2. Swollen cells present at intervals in the vegetative thallus | <i>M. farinosa</i> (1). |
| No swollen cells in the vegetative thallus | <i>M. Lejolisii</i> (2). |
| 3. Forming thick, lumpy expansions on <i>Corallina officinalis</i> ; conceptacles not prominent..... | <i>M. Corallinae</i> (4). |
| Forming thin layer (about 70 μ thick) on fragments of glass, porcelain and shells, scarcely visible when not in fruit | <i>M. zonalis</i> (3). |

1. *M. farinosa* Lamour. Lat. *farinosus*, mealy.—Thallus circular or irregularly lobed, cells squarish, or more frequently $1\frac{1}{2}$ times as long as broad; in vertical section basal cells squarish or slightly horizontally or vertically elongated, 8–14 μ diam.; heterocysts 22–36 μ by 12–18 μ . On some hosts cells may be smaller, exceptionally $2\frac{1}{2}$ times as long as broad, up to about 24 μ by 18 μ ; heterocysts mostly smaller, but may become 40 μ by 30 μ ; solitary small cortical cells frequently semicircular and distinct, sometimes indistinct, resembling those of *M. Lejolisii*. Conceptacles of sporang. and cystoc. hemispherical or hemispheric-conical, scattered or somewhat crowded, 140–250 μ diam.; tetrasporang. 50–90 μ by 30–50 μ ; antherid. conceptacles 60–80 μ in diam.

On other algæ, *Zostera*, chitin tubes of hydroids, tubes of *Serpula*, etc., mostly in upper part of sub-littoral region, seeming to prefer sheltered localities.

Not uncommon ; widely distributed.

var. **borealis** Lemoine.—Frond coarser, more lime-encrusted than type, new crust often developed over primary one ; cells

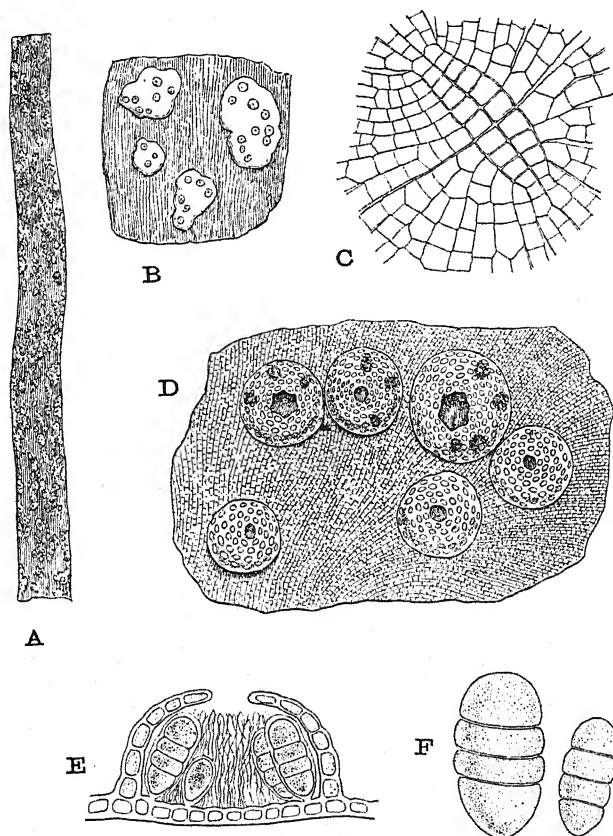


Fig. 187.—*Melobesia farinosa* Lamour. A. Colonies on host ($\times \frac{2}{3}$); B. The same ($\times 6$); C. Portion of colony, surface view ($\times 300$); D. Surface view of thallus with tetrasporic conceptacles ($\times 90$); E. Trans. sect. of single tetrasporic conceptacle ($\times 200$); F. Tetraspores ($\times 400$).

similar to type ; conceptacles usually larger, 200–300 μ in diam. Roundstone.

var. **callithamnioides** Foslie (*M. callithamnioides* Falk., non Crouan).—Slightly or greatly lacunose or composed of cell-rows, sub-dichotomous or radiating outwards from the centre ; cells

similar to type, sometimes larger or smaller, corners often rounded, usually sterile. Heterocysts sometimes almost circular. S. England.

2. *M. Lejolisii* Rosenv. After A. F. Le Jolis, French botanist.—Basal cells resembling those of *M. farinosa* in vertical section though sometimes smaller; square or elongated horizontally or vertically, $7-12\mu$ in diam.; the greater part of the frond, particularly in old specimens with crowded conceptacles, composed of 2-4 layers of cells or of new layers developed over the primary layers. Conceptacles of tetrasporang. and cystoc. convex or sub-hemispherical, frequently crowded, almost confluent, $150-250$ or 300μ in diam.; antherid. conceptacles $75-100\mu$. In young or poorly developed specimens conceptacles may be completely sunken or only slightly raised above the frond; tetrasporang. $50-80\mu$ by $30-50\mu$.

In the upper part of the sub-littoral region, in fairly sheltered places. Cornwall, Devon, Dorset, Galway and Cork.

3. *M. zonalis* Foslie (incl. *Hapalidium confervoides* Crouan and *M. myriocarpa* Crouan). Lat. *zonalis*, pertaining to a zone.—Thallus about 70μ thick, with radiating rows of cells seen from below, consisting of as many as 5 rows of cells, one of which forms the roof of the conceptacles. Cells 20μ by 10μ in the lower rows. Bispores 85μ by 30μ , in conceptacles $150-300\mu$ in diam., carpospores $30-40\mu$ by 20μ .

Forming a thin deep-red encrusting layer on glass, porcelain, shells and on other algæ. Not uncommon.

4. *M. Corallinæ* Solms. From the genus *Corallina*.—Thallus irregular, roundish or shield-shaped, generally from $80-400\mu$ thick, 1-5 mm. in diam. Inner portion consisting of a rhizoid-bearing layer and 12-15 layers of elongated rectangular cells, with a periphery of short cells. Segments dichotomous or unbranched and without stratification. Conceptacles sunk in the thallus, $150-200\mu$ diam.; tetrasporic conceptacles with one ostiole.

On *Corallina officinalis*. Not uncommon.

4. LITHOPHYLLUM Foslie

(Gr. *lithos*, a stone, and *phyllon*, a leaf.)

Forming calcareous incrustations; hypothallus well developed, perithallus of more or less loose filaments; in the branches of erect species medullary tissue present similar to the perithallus of procumbent forms. Conceptacles of sporang. immersed or sub-prominent, central parts of the roof at first convex, afterwards more or less decorticated, pierced by one ostiole; sporang. not isolated by separating walls as in *Lithothamnion*, arising round the periphery of a more or less arched disc, which is at first connected with the roof by a parenchyma-

tous strand. This finally breaks away, leaving a single pore in the roof, the process being usually simultaneous with the decortication of the conceptacle. Conceptacles of cystoc. immersed or sub-prominent, roof, or a part of it, forming a convex protuberance; carpospores arising round the periphery of the conjugation cell, bundle of short paranemata occupying the centre.

Key.

- | | |
|-------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Thallus branched..... | <i>L. fasciculatum</i> (4). |
| Thallus simple | 2. |
| 2. Orbicular crusts, about 2 cm. in diam. and 700 μ thick, epiphytic on the stipes of <i>Laminaria</i> ... | <i>L. Crouani</i> (3). |
| Thallus not epiphytic | 3. |
| 3. Orbicular crusts, about 2 cm. diam., 1-1.5 mm. thick, hypothallus feebly developed, often one layer, on stones | <i>L. orbiculatum</i> (2). |
| Hypothallus well developed | 4. |
| 4. Hypothallus well developed, rows of rectangular cells 20-22 μ \times 5 μ | <i>L. incrustans</i> (1). |
| Hypothallus cells 13-15 μ by 5-9 μ | <i>L. fasciculatum</i> (4). |

1. ***L. incrustans*** Foslie.—Forming thick crust, more or less irregular surface, closely adhering to the substratum, attaining thickness of 4 cm. and more; lower part very hard and calcareous, frequently enclosing small shells; hypothallus always well developed, formed of rows of regular rectangular cells, 3-5 times longer than broad; walls separating rows thick, cells 20-22 μ by 5 μ ; perithallus formed of loose rows of cells, variable size, rectangular or almost square, 6-12 μ by 5-8 μ , less regular in the upper parts; outer layer of small ovoid cells. Primary perithallus forms a secondary tissue separated from the primary by a cortical layer and primitive epidermis. New perithallus limited towards the exterior by a new cortex and new epidermis. In fruit, surface covered with ostioles, 50-80 μ diam.; young ostiole 15-20 μ broad, later enlarging, finally roof collapses, leaving larger cavities; tetrasporang. and bisporang. 100-150 μ long, 30-50 μ broad; cystoc. conceptacles convex, 150-250 μ in diameter.

Common; widely distributed (encrusting alga of pools and rocks on exposed shores).

var. ***Harveyi*** Foslie.—Lower hard portion absent. Surface covered with rounded regular excrescences. Common.

var. ***subdichotomum*** Heydr. (*L. dentatum* Foslie, f. *Macallana* Foslie).—Numerous compact rounded excrescences. Clew Bay, Roundstone Bay.

2. ***L. orbiculatum*** Foslie. Lat. *orbiculus*, a small disk.—Crust usually orbicular, scarcely exceeding 2 cm. diam., 1-1.5 mm. thick; hypothallus feebly developed, often consisting of one layer from which erect cells arise in rows vertically or almost so; perithallic cells 6-9 μ by about 13 μ . Con-

ceptacles of sporang. completely immersed, transverse inner diam. $92-116\mu$, usually almost globular in vertical section, with single orifice; tetrasporang. 70μ by $24-35\mu$, or rather larger. Empty conceptacles limited by sharp inner contour; antherid. conceptacles (?) with slightly prominent pore surrounded by narrow filaments obliquely placed, forming central part of roof; cystoc. conceptacles entirely immersed, inner diam. $112-142\mu$; pore surrounded by outer and inner crown of oblique filaments. Empty conceptacles sometimes filled with filaments growing out from bottom of conceptacle, sometimes overgrown without being filled.

On stones; S.W. Scotland.

3. **L. Crouani** Foslie. After P. L. and H. M. Crouan, French algologists.—Forming orbicular or suborbicular crusts, pale purplish when fresh, about 2 cm. diam., 700μ thick; surface smooth, sometimes slightly shiny; perithallic cells $16-21\mu$ by $10-14\mu$, hypothallus cells $30-40\mu$ or even 80μ long. Conceptacles crowded over the frond, except for a narrow peripheral portion, $90-110\mu$ in diameter, feebly decorticated when mature; tetrasporang. 45μ long by 30μ broad. Conceptacles finally overgrown.

Always paler than *Dermatolithon macrocarpum* f. *Laminariæ*, which it otherwise somewhat resembles externally.

On the stipes of *Laminaria Cloustoni*. Probably common; Berwick and Arran.

4. **L. fasciculatum** Foslie. Lat. *fasciculus*, a small bundle.—Thallus livid purple when fresh, roundish or irregularly lobed, $2.5-7.5$ cm. diam., composed of a central crust from which short, thick, irregularly dichotomous, cylindrical or laterally compressed crowded branches arise, all nearly fastigiate, truncated at the tips, which are sometimes sub-concave. Branches consisting of a medullary tissue of rows of cells, $13-15\mu$ by $5-9\mu$, representing the hypothallus, much reduced in some forms. Perithallus formed of rectangular cells, not in rows, $10-15\mu$ by $7-9\mu$, covered by a layer of small cells $7-10\mu$ by $10-12\mu$. Fructification unknown.

W. Ireland.

var. **eunana** Foslie.—Scantily branched or simple. W. Ireland.

var. **compressa** Foslie.—Upper part compressed, sometimes forming broad flattened branches. W. Ireland.

Dead material of *L. racemus* Foslie has been washed ashore at Falmouth.

Subgenus *Dermatolithon* Foslie

Conceptacles of sporang. sub-immersed, hemispherical or slightly conical with apical pore; sporang. with short foot

arising from disc between club-shaped free paraphyses. Conceptacles of cystoc. similar in form to tetrasp. conceptacles.

Key.

- | | |
|------------------------------------------------------------------------------|------------------------------|
| 1. Epiphytic on other algae..... | <i>L. pustulatum</i> (1). |
| On rocks, shells, etc. | 2. |
| 2. Cell size diminishing regularly from hypothallus to outside layers | <i>L. adplicitum</i> (3). |
| Cell size not diminishing regularly from hypothallus to outside layers | <i>L. hapalidioides</i> (2). |

1. ***L. pustulatum*** Foslie (*Melobesia pustulata* Lam., *M. verrucata* Lam.). Lat. *pustulatus*, blistered.—Thallus orbicular or

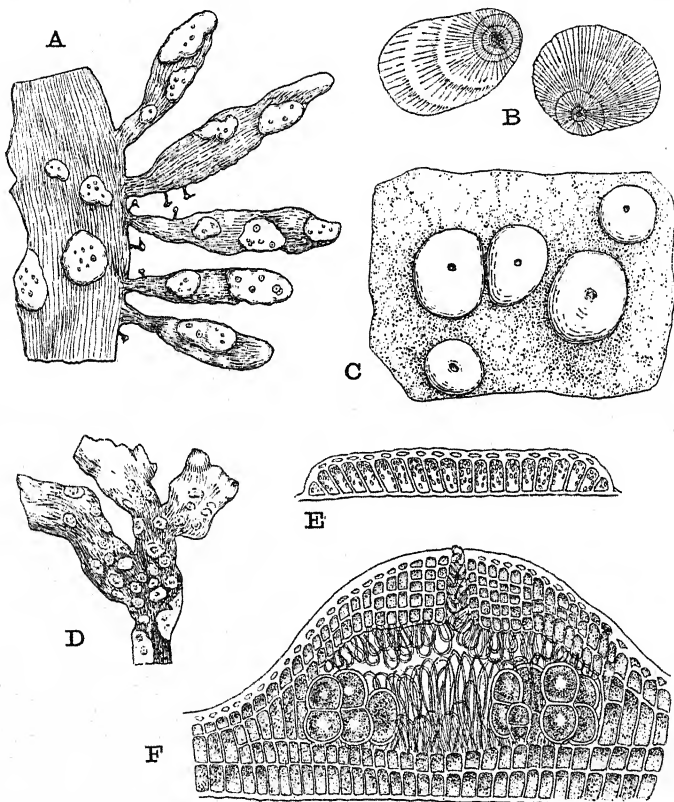


Fig. 188.—A.—C. *Lithophyllum pustulatum* Foslie. A. Colonies on host ($\times 1$); B. Young colonies ($\times 10$); C. Surface view with conceptacles ($\times 60$); D.—F. var. *Laminariae*. D. Colonies on host, nat. size; E. Trans. sect. of thallus ($\times 223$); F. Conceptacle bearing bisporangia ($\times 200$).

reniform, extremely regular, except on cylindrical hosts. Cell size and shape variable; in material from Clew Bay, described

by Lemoine, crust 60–130 μ , formed of 3–6 rows of cells, thickest in the centre; cells of the hypothallus 30–45 μ long, very variable, perithallus cells 10–60 μ long, all about 12 μ broad. Conceptacles conspicuous, hemispherical or somewhat conical, 400–600 μ diam. Bisporang. 40–55 μ by 25–40 μ .

Epiphytic on other algæ, particularly *Gigartina*. Similar to *D. hapalidioides*; cells attain a greater length in *D. pustulatum*.

Not uncommon; widely distributed.

var. *Corallinæ*.—On *Corallina officinalis*.

var. *Laminariæ* (*D. macrocarpum* f. *Laminariæ*).—Not uncommon; widely distributed.

2. *L. hapalidioides* Heydr. (*Melobesia hapalidioides* Crouan).—Occurring on shells and rocks, microscopic characters similar for both localities, external characters different. On shells, frond about 100 μ thick in the sterile part, circular in outline, margins thin, sometimes merging very gradually into the substratum. On rocks, frond 125–200 μ or more thick, more violet than the shell form, margins slightly raised from the substratum, surface irregular on account of the presence of numerous little secondary plates. Tissue composed, in both forms, of several cell-layers, usually 3–6, uppermost row formed of tiny cells; perithallus represented by 1–4 rows of cells; hypothallus by a row of larger cells obliquely placed; cell size not diminishing regularly from the hypothallus to the outside layer as in other species; cells 12–13 μ broad, length varying considerably in different parts of the same thallus. Conceptacles hemispherical, protruding from the surface, 250–600 μ in diameter; tetrasporang. 70–80 μ by 30–40 μ , both tetraspores and bispores observed.

Not uncommon; S. England, Northumberland and Ireland.

3. *L. adplicitum* Newton. (*Dermatolithon adplicitum* Foslie). Lat. *adplicatus*, attached.—Thallus a somewhat uneven crust, 2–3 cm. in diam., 300–600 μ thick, in places adhering only loosely to the substratum, gradually decreasing towards the margin with a few small wart-like or irregular excrescences. In places feebly zonate towards the margin of the thallus, the margin irregularly crenate with or without a thin whitish rim. Conceptacles convex or nearly hemispherical or sometimes approaching a low conical shape, 550–650 μ diam. at the base, densely crowded in the peripheral portions, often becoming angular. At maturity, greater part of roof falls away, leaving shallow scar with raised edges. Some conceptacles found to be overgrown; probably not occurring if whole roof falls away, as they are superficial or nearly so.

Single British record, attached to a *Pholas* shell, partly growing over Bryozoa and other Lithothamnina. Bognor.

5. LITHOTHAMNION Foslie

(Gr. *lithos*, a stone, and *thamn*os, a branch.)

Thallus calcareous, consisting of a flat plate-like structure from which coralloid branches, wart-like projections or undulating lobes may arise. Tetrasporang. in superficial or sub-immersed soriform conceptacles, each sporang. at first isolated by parenchymatous wall, which is sometimes dissolved at a later stage; roof of conceptacle perforated by a number of orifices, below each of which is a tetrasporang.; cystoc. on the surface of the thallus, more or less conical; roof with a single orifice.

Differing from *Lithophyllum* by the presence of the separating walls in the tetrasp. conceptacles and by the large number of openings in the roof of the same.

- | | |
|-------------------------------------------------------------------------------|-----------------------------------|
| 1. Thallus composed of a single cell-layer except near the conceptacles | <i>L. membranaceum</i> (9). |
| Thallus more than one layer thick | 2. |
| 2. Thallus encrusting | 3. |
| Thallus branched | 4. |
| 3. Conceptacles finally immersed in the tissues of the frond | Species 1 (in part) 2, 10 and 12. |
| Conceptacles superficial, not immersed in the frond | Species 5, 6, 7, 8 and 11. |
| 4. Conceptacles finally immersed in the tissues of the frond | Species 1 (in part) and 3. |
| Conceptacles superficial, not immersed in the frond | Species 4. |

For further information the following should be consulted:—Foslie, "Norwegian forms of *Lithothamnion*." Trondhjem, 1895. Lemoine, "Structure anatomique des *Mélobésiées*," *Annales Institut. océanographique*, ii, fasc. 1, pp. 1-213, 105 figures, 5 plates. Monaco, 1911. Lemoine, "Mélobésiées de l'ouest de l'Irlande," *Nouvelle Archives du Muséum d'histoire naturelle*, 5^e série v, pp. 121-145. Paris, 1913.

1. *L. glaciale* Kjellm. (*L. flabellatum* Batt., non Rosenv.). Lat. *glacialis*, frozen.—When young forming a thick rose-coloured calcareous crust devoid of branches, later bearing conical protuberances and branchlets as much as 0.5 cm. long; when old, spherical protuberances 15-20 cm. diam. may be present. Hypothallus cells 10-22 μ by 6-10 μ ; perithallus cells squarish, 5-7 μ diameter. Conceptacles with circular or oblong and convex roof, 300-350 μ diam., sometimes reaching 400 μ . Intersected with 50-70 canals, crowded into middle of roof. Later this portion becomes depressed, giving the conceptacles the appearance of possessing an annular border. Tetrasporang. as much as 180 μ by 50 μ .

Usually in sheltered places on a sandy or shingly bottom ; Bute.

2. *L. colliculosum* Foslie. Lat. *colliculus*, a little hill.—Forming a dark-red crust, 0.5–1.5 mm. thick, getting paler on removal from the water, closely adherent to the substratum. When old, bearing small tubercles or short simple branches not exceeding 4 mm., terete, either cylindrical or tapering, or enlarged towards the tips with ends obtuse or rounded, 1–2 mm. diam., sometimes bearing wart-like processes ; edges of adjacent plants meeting often form rough wavy ridges. Basal layer thin ; conceptacles scattered over the crust and processes, conical, usually acute, 300–500 μ diam. at the base ; carposp. pyriform, ovate or even subspherical, 45–120 μ by 20–60 μ .

Not uncommon ; S. Scotland and W. Ireland.

var. *rosea* Batt.—Tubercles 2–3 mm. diam., cylindrical, cylindric-conical or thickened upwards, as much as 8 mm. high ; warty processes may be simple, bifid or trifid.

3. *L. Battersii* Foslie. After E. A. L. Batters, British algologist.—Frond curved or angularly bent, 1.3–2 cm. by 2–3 mm. ; frequently more or less densely furnished with short branchlets or wart-like processes, varying in thickness from 0.5–1.5 mm., ends rounded or obtuse, surface smooth or with scaly thickenings. Conceptacles scattered over the frond, sometimes 2 or 3 confluent or nearly so, convex, rather flattened, very little prominent, 250–300 μ diam. ; roof thick, canals visible in late stage, about 30. Sporang. bisporic, 90–120 μ by 35–45 μ .

At depth of about 7 fathoms. Bute.

4. *L. calcareum* Aresch. (*L. coralloides* Crouan). Lat. *calcarius*, pertaining to lime.—Very variable in form, encrusting when young, later branched and coralloid, characterised by small cells, those of the crust rectangular, generally ovoid, 9–20 μ by 4 μ , those of the hypothallus 6–10 μ by 5 μ , perithallus cells 7–9 μ by 5 μ . Conceptacles scattered or crowded in the upper part of the branches, slightly convex, not prominent, 300–350 μ diam., roof traversed by about 40 canals. Cystoc. conceptacles low, conical, 350–400 μ diam. at the base, traversed by canal 20 μ in diam.

Very fragile, encrusting pebbles when young, preferring hard bottom and sheltered habitat, upper and lower sub-littoral zone. W. England, Scotland and Ireland.

var. *compressa* Fosl.—Frond compressed, branches flat, broader towards the tips. West of Ireland.

var. *norvegicum* Fosl.—Tufted, unattached ; branches terete, scattered irregularly ; lobes subfasciculate, expanded irregularly along their longitudinal axes, fastigiata. Cystoc. in the thickened apices of the branches. West of Ireland.

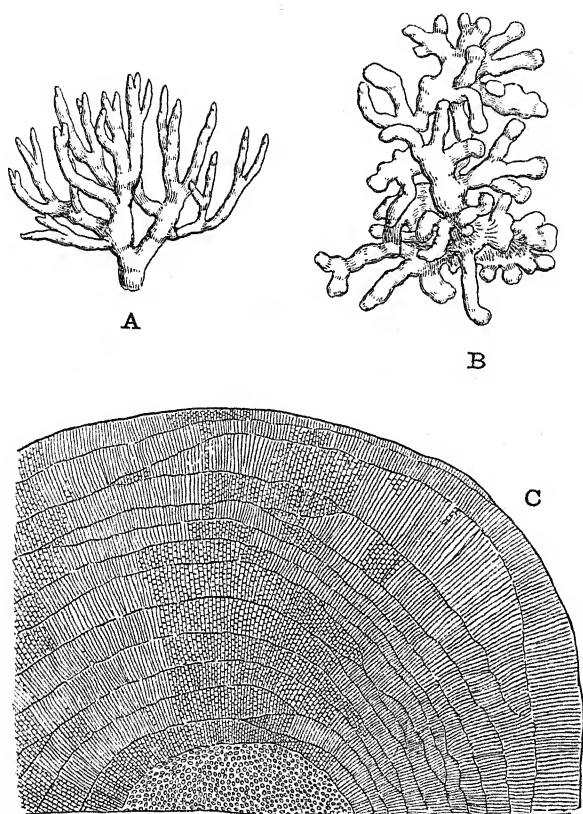


Fig. 189.—*Lithothamnion calcareum* Aresch. A. On muddy substratum ($\times 1$); B. From Clew Bay, 5 fathoms ($\times 1$); C. Section ($\times 90$).

5. **L. Sonderi** Hauck. After O. W. Sonder, German botanist. —Thallus pink, sometimes tinged with lilac, encrusting, 0.2–2 mm. thick, attached to the substratum by its undersurface. Tetrasp. conceptacles scattered over the frond, circular or nearly so, very little raised, $350\text{--}400\mu$ diam.; central portion depressed, leaving shallow scar, effaced later by thickening of the frond, but contributing to unevenness of the surface. Roof pierced by 80–100 canals; tetrasporang. $100\text{--}140\mu$ by $35\text{--}60\mu$; cystoc. conceptacles rather low, $400\text{--}450\mu$ diam. at the base; spores nearly elliptical, elongated-obovate or broadly cuneate, $50\text{--}80\mu$ by $35\text{--}40\mu$ broad in broadest part; antherid. conceptacles $250\text{--}300\mu$ diam. at the base.

Attached to smaller stones in upper part of sub-littoral region. S.W. Scotland, E. and W. Ireland.

6. *L. lichenoides* Foslie (*Melobesia lichenoides* Harv.). Lichen and *Gr. eidos*, like.—Frond dark purple in deep water, much paler nearer high-water mark. attached at the base, free at the margins, foliaceous, lobed, leafy portions often imbricate, semicircular, $200-400\mu$, 1.5–2 cm., upper surface concentrically marked. Conceptacles hemispherical, or obtusely conical, scattered or collected into groups, 0.8–1.3 mm. diam.

Thin and brittle, spreading over rocks and stones in more or less circular patches. On rocks and in tide-pools near low-water mark. Rather rare; S. England and Channel Islands, W. of Ireland and Isle of Man.

var. *agariciformis* Fosl. (*Melobesia agariciformis* Harv.). Unattached, globular, hollow. W. Ireland.

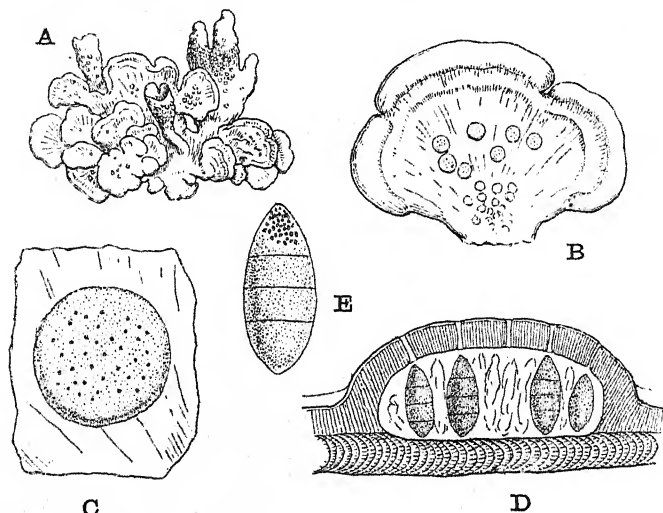


Fig. 190.—*Lithothamnion lichenoides*. A. ($\times 1$); B. Colony ($\times 8$); C. Tetrasporic conceptacle surface view ($\times 14$); D. The same in trans. sect. ($\times 30$); E. Tetraspore ($\times 60$).

7. *L. Lenormandi* Foslie f. *typica* Foslie. After S. R. Lenormand, French naturalist.—Forming thin lilac encrustations, firmly attached by under-surface, 0.1–0.6 mm. thick, roundish or lobed. Conceptacles densely crowded over the whole frond, except at the margins, often confluent, with angular roofs; hemispherical or nearly so, $250-350\mu$ diam.; roof of tetrasporic conceptacles with 25–35 canals. Towards maturity roof becomes flattened, later disintegrates, leaving annular border which contributes to unevenness of frond. Tetrasporang. $60-80\mu$ by $20-35\mu$.

In rock pools or on rocks or shells in lower littoral or sub-littoral region. Not uncommon; widely distributed.

—f. *sublævis* Fosl. Conceptacles larger than in f. *typica*, roof 300–400 μ diam., more flattened. Berwick.

—f. *squamulosa* Fosl. On the sides of dark caves. Clare Island.

8. *L. Stroemfeltii* Fosl. After H. F. G. Stroemfelt, Swedish algologist.—Thallus deep pink, encrusting, closely adnate to the substratum by the whole under-surface, suborbicular, 2 cm. or more diam., 100–600 μ thick; surface smooth, when not in fruit. Cystoc. conceptacles conical, frequently rather acute, 600–800 μ diam. at the base, traversed by a large canal, often visible to the naked eye; spores frequently broadly cuneate, 150–250 μ by 80–130 μ ; conceptacles of antherid. on the same individual, 300–400 μ diam. at the base; spermatia irregular, most frequently rounded, compressed, thin, 80–100 μ diam. Roof of the tetrasporangial conceptacle pierced by 80–120 canals, cup-shaped scar with raised edges remaining after roof has disintegrated. Scars often filled with new tissue; local thickening may be small, effacing the scar only; or large, forming lamellate markings.

Attached to smaller stones and shells in protected places, upper and lower sub-littoral zones; in exposed localities in deeper water. "Common in Ireland."

Closely allied to *L. Lenormandi*; distinguished by colour, shape and size of reproductive organs, and in typical specimens by smooth surface and more numerous muciferous canals.

9. *L. membranaceum* Fosl. (including *L. corticiforme* Fosl.).—Thallus purplish encrusting, forming semi-transparent filmy patches, at first orbicular, then indefinite in outline, one cell thick except near the reproductive organs. Cells 9–13 μ by 5–8 μ , sometimes larger when growing on *Cladophora*, arranged in simple or dichotomous lines radiating towards the margin of the frond. Tetrasp. conceptacles hemispherical, 10–130 μ diam.; roof pierced by 7–18 pores (rarely 20–30) when young, later disintegrating to form one oval cavity; tetraspores zonate; cystoc. conceptacles 120–175 μ diam., pierced by a single orifice about 20 μ in diameter; when mature, roof disintegrates, leaving a circular cavity. Conceptacles numerous but not confluent.

Epiphytic on other algæ and on shells. Not uncommon; widely distributed.

10. *L. lævigatum* Fosl. (*Phymatolithon lævigatum* Fosl.). Lat. *levigatus*, slippery.—Forming extended crusts, closely adherent to the substratum when young, more or less easily detached when older. Thallus 0.3–0.8 mm. thick in the centre, decreasing towards the entire margin, shallowly crenate or lobed, peripheral portion frequently more or less indistinctly zonate; surface otherwise smooth, feebly shiny, never with excrescences. Conceptacles not conspicuous, scattered in great numbers over the frond except for a narrow peripheral band which is sterile;

sporang. immersed, in sharply defined cups 150–200 μ diam. ; roof of tetrasp. conceptacles with 40–55 canals ; asexual sporang., usually bisporic, 120–150 μ by 40–60 μ , about 15–20 μ thick. Colour varying, frequently purplish, bluish or yellowish brown.

On rocks and stones in 5–6 fathoms of water. Not common ; Northumberland and West of Ireland.

11. *L. compactum* Kjellm. (*L. circumscriptum* Strömfelt, *Clathromorphum circumscriptum* Foslie).—Forming thin crusts hardly 1 mm. thick. Cells 7–9 μ by 4 μ , conceptacles very crowded and angular, the partitions separating them being very thin. After the ripening of the conceptacle the upper part becomes detached, leaving the surface of the frond like a honeycomb. Conceptacles near the middle of the frond, margin sterile ; roof of the asexual conceptacles with 10–20 pores ; sporang. usually bi-sporic, 120–160 μ by 50–80 μ .

In 9–12 fathoms of water. W. Ireland.

12. *L. polymorphum* Foslie (*Phymatolithon polymorphum* Fosl.).—Thallus dark, encrusting, about 6 mm. thick, variable, surface irregular, structure compact. Hypothallus and perithallus equally developed, the former in numerous cell-rows closely packed together, the latter small rectangular ovoid cells 5–8 μ by 4 μ . Conceptacles distributed uniformly over the frond, immersed ; tetrasp. conceptacles oblong or round, 150–400 μ diam., roof pierced with 30–70 canals, disintegrating when mature, leaving annular border ; tetrasporang. 90–100 μ by 25–45 μ ; cystoc. conceptacles slightly convex, 140–400 μ diam. ; antherid. conceptacles 100–120 μ diam.

Infertile specimens may be distinguished from *L. glaciale* by the cell structure and size, the cells of *L. polymorphum* being much more compact.

Forming incrustations on rocks and on the sides of rock-pools. Not uncommon ; widely distributed.

6. CORALLINA Lamour.

(Gr. *corallion*, a coral.)

Thallus erect, cylindrical or compressed, jointed, arising from a calcareous disc or a mass of interlacing filaments, much branched, branches pinnate or dichotomous ; central core of dichotomous, more or less parallel filaments, from which oblique filaments grow outwards forming a cortical layer, the whole being covered by a dense cuticle. Conceptacles bearing antherid., carposp. or tetrasp. terminal, sometimes with horn-like appendages. Plants monoecious or dioecious, lime-encrusted.

Key.

- | | |
|------------------------------------------------------------------------|------------------------|
| 1. Branches pinnate | 2. |
| Branches dichotomous | <i>C. rubens</i> (5). |
| 2. Thallus filamentous, 180–350 μ thick in the main branches | <i>C. virgata</i> (4). |
| Diam. of the main branches more than 350 μ thick... | 3. |

3. Attachment disc present, segments of the branches
very slightly compressed, pyriform..... 4.
Attached by interlacing branches, segments
markedly compressed, strongly obconical in upper
parts of main branches *C. squamata* (3).
4. Horns on conceptacles *C. elongata* (2).
Horns absent *C. officinalis* (1).

1. *C. officinalis* Linn. Lat. *officina*, a shop.—Plants diœcious, dull purple when growing in deep water, becoming red, yellow and finally white on exposure. In tufts, 5–12 cm. high, pinnately branched, branches opposite, 0.5–1.5 mm. in diameter, branchlets 160μ to 1 mm. in diameter. Segments at the base of the main branches about as long or slightly longer than broad, 2–6 times their breadth in the upper parts; cylindrical or ovoid, pyriform when bearing branchlets. Male conceptacles elongated at the apex, female conceptacles and those bearing tetrasp. ovoid.

On rocks between the tide marks, generally growing in rock pools. Common; widely distributed.

var. *compacta* Batt. (*C. compacta* Crouan). Hemispherical cushion, very compact. Rare; Devon and Dorset.

2. *C. elongata* Johnst. (*C. mediterranea* Aresch.).—Fronde branched from the base, branches bipinnate, segments ovate or subtriangular, pinnules subcylindrical. Conceptacles terminal, pyriform, attenuate below, bearing one or more horns, shorter than broad.

Rare; S. England, Ireland and Jersey.

3. *C. squamata* Ellis. Lat. *squamatus*, scaly. Plants monœcious, dark purple, soon fading on exposure. In tufts 4–10 cm. long, attached by interlacing branchlets, pinnately branched, branches and branchlets opposite those near the apices of the branches sometimes dichotomous. Segments near the base of the plant scarcely as long as broad, in the upper parts very much compressed and markedly obconical with occasional cylindrical segments. Male conceptacles lanceolate; female and asexual ovoid.

Differing from *C. officinalis* in the form of the attachment organ and the broad, flat, angular segments in the upper parts.

On rocks, near low-water mark. Not uncommon; S. of England and the Channel Islands.

4. *C. virgata* Zanard. Lat. *virgatus*, made of twigs.—Forming dense tufts, 2–4 cm. high; thallus filamentous, 180 – 350μ thick in the main branches, 60 – 160μ thick in the branchlets; branches opposite and pinnate or di-trichotomous, main axis often bearing whorls of branchlets which may be pinnately or irregularly branched. Segments cylindrical or broadened at the apex where the branches arise, 5–6 times longer than broad in the branchlets, 3–4 times in the main axes. Conceptacles ter-

minial, the male ovoid, without horns, female and asexual urn-shaped, with 2 or rarely 3 horns.

Usually epiphytic on other algæ, such as *Cystoseira*. Very rare; Northern Ireland.

5. *C. rubens* Ellis & Soland. (*Jania rubens* Lamour). Lat. *rubens*, reddish.—Plants monœcious, pale red or purplish. In dense tufts, 2–5 cm. high, much branched, branches dichoto-

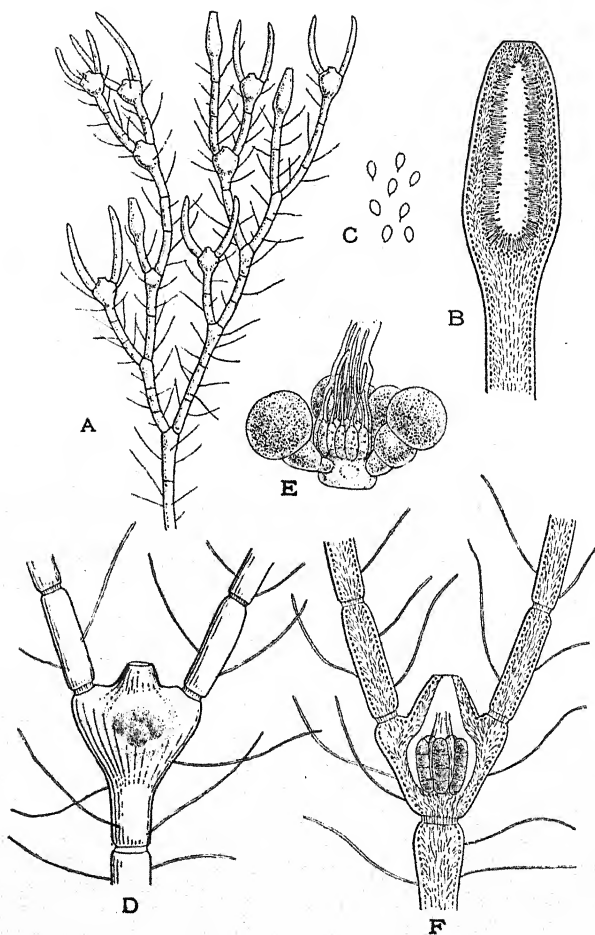


Fig. 191.—*Corallina rubens* Ellis & Soland. A. Portion of thallus ($\times 14$); B. Longit. sect. through male conceptacle ($\times 40$); C. Spermatia ($\times 300$); D. Cystocarpic conceptacle ($\times 30$); E. Portion of the same ($\times 110$); F. Tetrasporic conceptacle ($\times 30$).

mous ; segments 150–250 μ diam. near the base, rather less above, cylindrical throughout, or very slightly enlarged at the apices bearing branchlets, 3–6 times as long as broad. Male conceptacles lanceolate, without apical branchlets ; female and asexual bearing two branchlets near the apex, ostiole somewhat elongated.

Epiphytic on the smaller algæ between the tide-marks. Common ; S. England, Ireland and the Channel Islands ; rarer in Scotland.

var. *corniculata* Hauck (*Jania corniculata* Lamour.).—Upper angles of the segments of the main axes more or less elongated and angular. Not uncommon ; S. England, Ireland and the Channel Islands.

Order IV.—CERAMIALES

Distinguished from all other Florideæ by the fact that the auxiliary cell is not developed until after the fertilisation of the carpogonium.

Family I.—DELESSERIACEÆ

Thallus leafy, with or without a mid-rib.

Tribe 1. *DELESSERIAE*.—Procargs developed on the mid-rib.

1. *DELESSERIA* Lamour.

(After Baron Delessert, French naturalist.)

Frond bright red, thin, membranaceous, laciniate or branched, with a conspicuous mid-rib and macro- or microscopic lateral veins, sometimes proliferous from the mid-rib. Cystoc. stalked, on the mid-rib ; tetrasp. in small sori on the mid-rib.

D. sanguinea Lamour (*Hydrolapathum sanguineum* Stackh.). Lat. *sanguineus*, blood-red.—Stipe cartilaginous, 2.5 to 15 cm. or more in length, more or less branched, cylindrical or irregular, producing irregularly placed leafy fronds at intervals ; fronds fine crimson, membranaceous, stipitate 10–25 cm. or more long, tapering below, oblong or obovate, obtuse or acute, sometimes lanceolate ; when young nearly flat, when old much waved, margin entire ; mid-rib conspicuous, bearing lateral, patent or horizontal pinnate veins, arising at short equal distances ; sometimes proliferous from the mid-rib, occasionally divided into several deep undulated lobes. Cystoc. and tetrasp. on the

membraneless mid-ribs of old fronds in winter; cystoc. mostly on one side of the mid-rib; tetrasp. on leafy proliferations.

In deep pools, usually in the shade and in deeper water. Common; widely distributed.

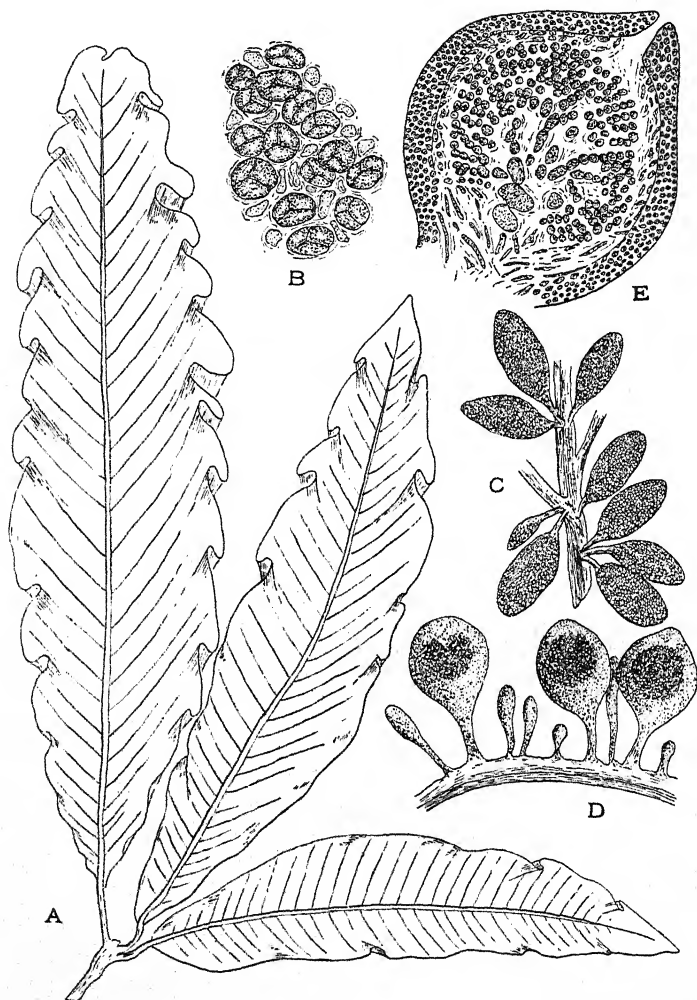


Fig. 192.—*Delesseria sanguinea* Lamour.—A. plant ($\times 1$); B. Surface view of thallus bearing tetrasp. ($\times 80$); C. Leafy proliferations of mid-rib bearing tetrasporang. ($\times 6$); D. Mid-rib bearing cystocarps ($\times 6$); E. Trans. sect. cystocarp ($\times 50$).

2. MEMBRANOPTERA Stackh.

(Gr. *membrana*, parchment, and *pteron*, wing.

Thallus flat, with conspicuous mid-rib; leafy portion monostromatic, mid-rib polystromatic; frond linear, with marginal

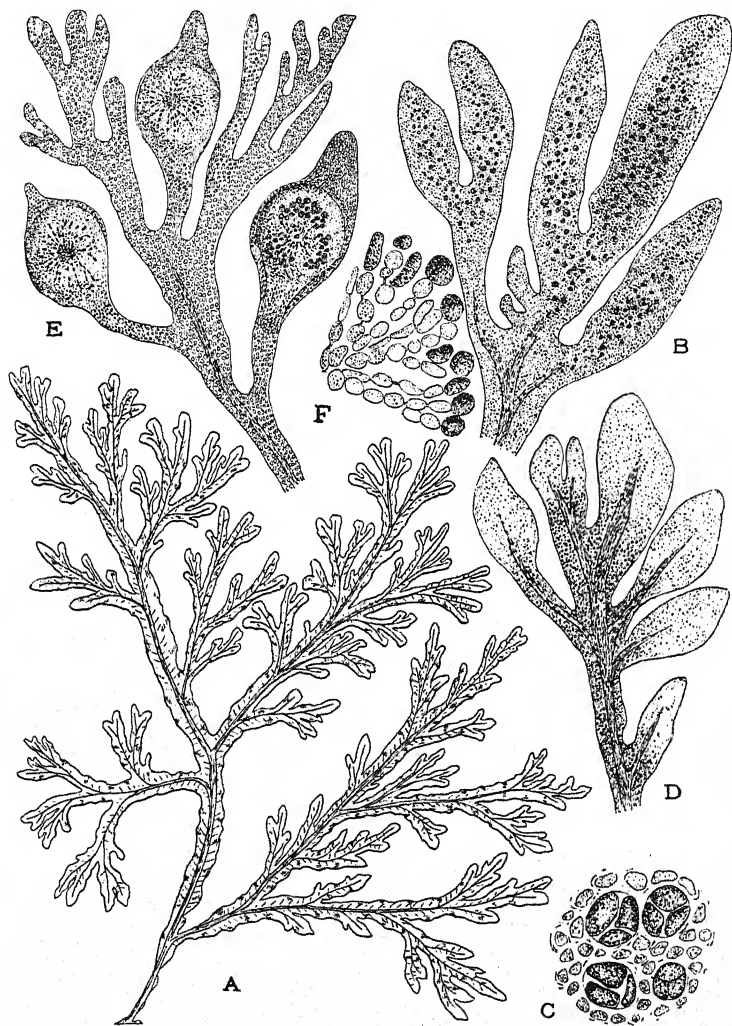


Fig. 193.—*Membranoptera alata* Kylin. A. Plant ($\times 3$); B. Portion bearing tetrasp. ($\times 6$); C. Surface view of thallus with tetrasp. ($\times 80$); D. Portion bearing antherid. in colourless tips ($\times 6$); E. Frond with cystocarps ($\times 6$); F. Developing carpospores ($\times 80$).

growth, irregularly dichotomous or pinnate. Cystoc. on the mid-rib; antherid. near the tips of the lamina; tetrasp. in sori, in the apices of the frond or in proliferous leaflets.

M. alata Kylin (*Delesseria alata* Lamour.). Lat. *alatus*, winged.—Frond deep crimson, dark red or brownish, membranaceous, 10–20 cm. long, much branched, irregularly dichotomous, main divisions alternate or pinnate; branches attenuate at the apices, consisting of a prominent mid-rib, bordered with a wing-like membranous lamina, pinnately veined, often broader on one side than the other, axils rounded; often proliferous from the mid-rib. Cystoc. convex, immersed near the apices of the branches; tetrasp. in terminal sori on each side of the mid-rib or on the apices of small proliferations.

On rocks and the larger algæ, between the tide-marks and in deeper water. Common; widely distributed.

3. PANTONEURA Kylin

(Gr. *pante*, entirely, and *neuron*, a nerve.)

Thallus cylindrical or flattened, polystromatic without monostromatic leafy frond. Cystoc. embedded in the mid-rib, near the apices of the frond or on small axillary ramuli; tetrasp. in sori either in the inflated apices or in axillary lanceolate ramuli.

P. angustissima Kylin (*Delesseria angustissima* Griff.). Lat. *angustissimus*, very narrow.—Fronds dark red, cartilaginous,

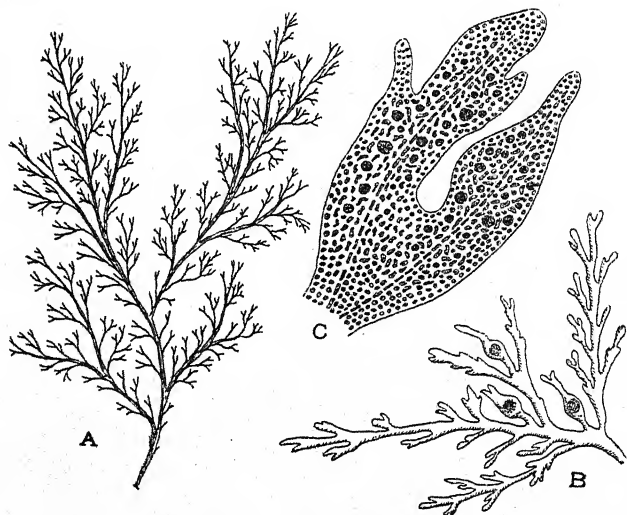


Fig. 194.—*Pantoneura angustissima* Kylin.—A. Plant ($\times \frac{2}{3}$); B. Portion bearing cystoc. ($\times 6$); C. Surface view of thallus with tetrasp. ($\times 30$).

rather flaccid, tufted, 10–20 cm. long, nearly cylindrical below, compressed and two-edged above, attenuate upwards, much and irregularly branched; branches distichous, irregular, alternate or sub-dichotomous, frequently naked below, furnished above with patent, once or twice forked ramuli, apices acute. Cystoc. spherical.

Epiphytic on the stems of *Laminaria*. Not uncommon; N. England, Scotland and Ireland.

4. APOGLOSSUM Kylin

(Gr. *apo*, sprung, from *glossa*, tongue.)

Mid-rib conspicuous, lateral veins microscopic, cells of the mid-rib bounded by a layer of corticating cells; frond leafy, repeatedly proliferous from the mid-rib. Cystoc. on the mid-ribs of the smaller fronds; antherid. in elongated sori in the leafy portion; tetrasp. in linear sori at each side of the mid-rib.

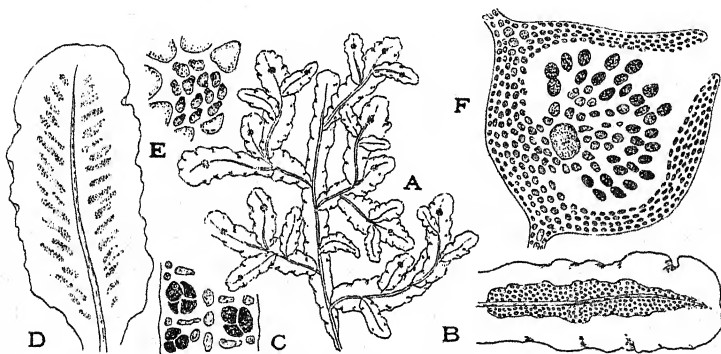


Fig. 195.—*Apoglossum ruscifolium* Kylin. A. Plant ($\times \frac{2}{3}$); B. Tip of frond showing position of tetrasporic sori ($\times 10$); C. Trans. sect. frond with tetrasporang. ($\times 100$); D. Portion of frond showing antheridial sori ($\times 10$); E. Surface view of antheridia ($\times 250$); F. Trans. sect. cystocarp ($\times 66$).

A. ruscifolium Kylin (*Delesseria ruscifolia* Lamour.). *Ruscus*, a genus of flowering plants, and *Lat. folium*, a leaf.—Fronds bright red, somewhat rigid, tufted; primary frond 5–10 cm. long, linear-oblong, obtuse, undivided, margin entire, often wavy, with conspicuous mid-rib, producing numerous leafy fronds which may themselves be proliferous from the mid-rib; lateral veins microscopic. Antherid. in numerous parallel sori.

On rocks near low-water mark, sometimes epiphytic on other algæ. Rather rare; widely distributed.

5. **HYPOGLOSSUM** Kütz.(Gr. *hupo*, underneath, and *glossa*, a tongue.)

Thallus small, leafy, monostromatic except in the mid-rib., proliferous from the mid-rib, bearing small fronds similar to the primary thallus. Cystoc. in the mid-ribs of the smaller leaflets, usually near the centre; tetrasp. forming linear patches on each side of the mid-rib.

H. Woodwardii Kylin (*Delesseria hypoglossum* Lamour., var. *Woodwardii* Hauck). After T. J. Woodward, British algologist.—Fronds rose-red, membranaceous, tufted, consisting of a

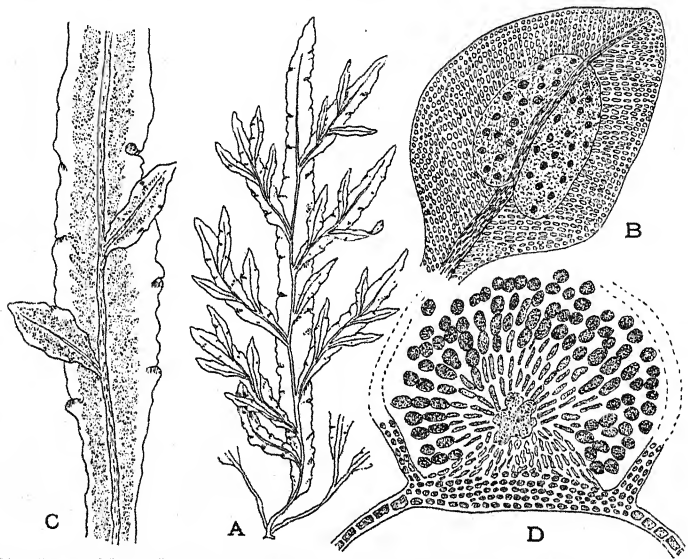


Fig. 196.—*Hypoglossum Woodwardii* Kylin. A. Plant ($\times \frac{2}{3}$); B. Portion of thallus showing tetrasporic sorus ($\times 20$); C. Portion showing antheridial sori ($\times 6$); D. Trans. sect. cystocarp ($\times 60$).

primary linear-lanceolate thallus, 5–20 cm. long, with distinct mid-rib and faint traces of obliquely transverse lateral veins; proliferous from the mid-rib, the smaller fronds being again proliferous, resulting in a bushy tuft; apices tapering or acute. Cystoc. globose; antheridia in linear sori near the mid-rib.

On rocks and on other algæ. Not uncommon in England, Ireland and the Channel Islands; rare in Scotland.

var. *ovalifolia* J. G. Agardh.—Segments egg-shaped. Rare; Orkney Islands.

var. *glomerata* Chauv.—Segments numerous, lanceolate, obtuse. Dorset and Orkney.

var. *arborescens* J. G. Agardh.—Segments palmate. Cornwall, Devon and Orkney.

var. *crispa* Crouan.—Thallus more wavy than the type. Cornwall.

var. *angustifolia* Kütz.—Very small and delicate. Rare; Dorset, Bute and Jersey.

Tribe 2. *NITOPHYLLEÆ*.—Procarys scattered on the thallus.

6. *NITOPHYLLUM* Grev.

(Lat. *nitor*, brightness, and Gr. *phullon*, a leaf.)

Thallus very thin, frond sessile or very shortly stipitate, microscopic veins absent, mono- or polystromatic. Cystoc. on the surface of the thallus, one group of sterile cells present; carposp. not in chains; tetrasp. in roundish or elongated sori, scattered on the surface of the thallus.

N. punctatum Grev. Lat. *punctus*, a small dot.—Thallus membranaceous, clear rose-pink, very thin and delicate, 10-50

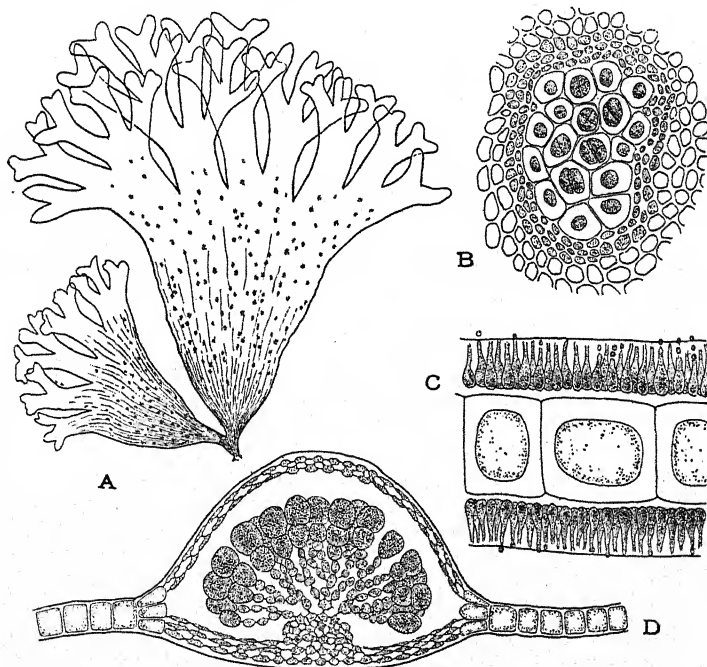


Fig. 197.—*Nitophyllum punctatum* Grev. A. Plant ($\times \frac{1}{2}$); B. Surface view of thallus with tetrasp. ($\times 55$); C. Section of thallus with antheridia ($\times 550$); D. Trans. sect. through cystocarp ($\times 55$).

cm. or more long and broad, veins absent, either regularly dichotomous or cleft into 2 or 3 principal segments, the margins fringed with dichotomous lobes; axils rounded, margins often forming folds.

Attached to various algæ in pools at low-water mark and more abundantly at greater depth. Not uncommon; widely distributed, rather local.

var. **ocellatum** J. G. Agardh.—Fronde with a roundish outline, cleft almost to the base, the segments repeatedly dichotomous, linear. Rare; widely distributed.

var. **crispatum** Harv.—Fronde thickish, cleft nearly to the base, the segments irregularly dichotomous, linear, margin strongly curled. Rare: widely distributed.

var. **Pollexfenii** Harv. (*N. alliaceum* Tellam).—Fronde proliferous, young segments broadly obovate, rounded, very entire or bifid. Very rare; Cornwall and Orkney.

var. **fimbriatum** Harv.—Segments broadly obovate, fringed with narrow forked processes. Very rare; Roundstone Bay and Orkney.

var. **reniforme** J. G. Agardh.—Sub-reniform and palmately divided. Very rare; Orkney.

7. MYRIOGRAMME Kylin

(Gr. *urias*, countless number, and *gramme*, a line.)

Thallus flat, leafy, irregularly bushy or lobed or deeply divided, upper parts monostromatic, lower parts polystromatic. Veins present or absent, microscopic veins absent. Cystoc. distributed on the thallus, two groups of sterile cells present, carposp. produced in chains; tetrasp. in small sori, irregularly distributed on the upper surface of the thallus.

Key.

Veins present at the base, 5–10 cm. long..... *M. Bonnemaisoni*.
Veins absent, 2–5 cm. long, changing to golden
orange in contact with fresh water..... *M. versicolor*.

M. Bonnemaisoni Kylin (*Nitophyllum Bonnemaisoni* Grev.). After T. Bonnemaison, French algologist.—Plant rosy red, membranaceous, stipitate; stipe cylindrical, expanding into a fan-shaped frond, 5–10 cm. long, rather broader than long, usually veined near the base; sometimes broad, not deeply cleft; sometimes cleft nearly to the base in long ribbon-like segments; divisions more or less regularly dichotomous, margin sometimes proliferous. Cystoc. small; tetrasp. in oval or rounded sori.

On stipes of *Laminaria*, and rocks and stones in 4–5 fathoms. Rare; widely distributed.

var. **crassinervia** Batt.—Very rare; Scilly Isles, Berwick and Orkney.

2. *M. versicolor* Kylin (*Nitophyllum versicolor* Harv.). Lat. *versicolor*, of various colours.—Stipitate below, stipe irregularly tuberous or broadened below, 2–5 cm. long, fleshy, cartilaginous, expanding sharply into a broadly fan-shaped, variously cleft

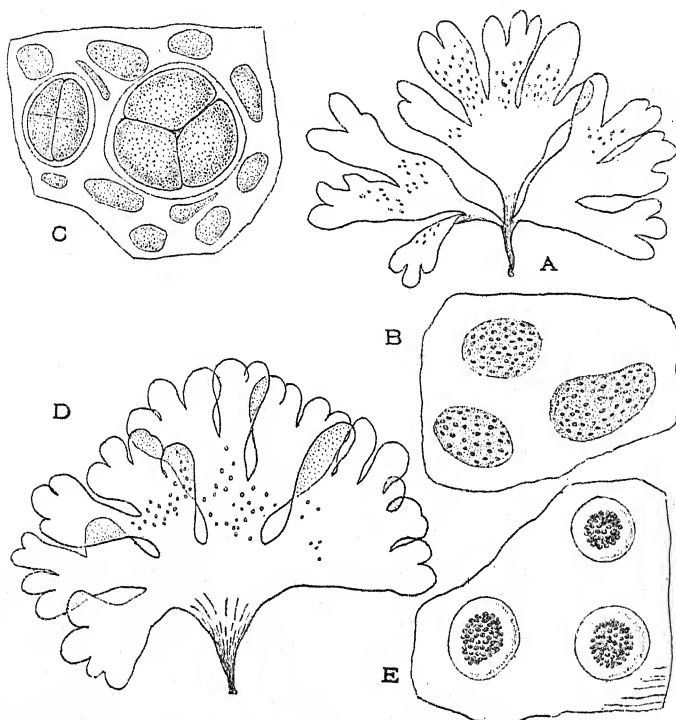


Fig. 198.—*Myriogramme Bonnemaisoni* Kylin. A. Tetrasporic plant ($\times \frac{3}{8}$); B. Surface view of the same with sori ($\times 25$); C. Surface view of portion of sorus showing tetrasporang. ($\times 300$); D. Cystocarpic plant ($\times \frac{3}{8}$); E. Surface view of the same with cystocarps ($\times 25$).

frond, rosy red when fresh, changing to golden orange in contact with fresh water; segments rounded, often dichotomous. Fructification unknown.

Very rare, probably thrown up from deep water; S. England, Youghal.

8. *ACROSORIUM* Zanard.

(Gr. *akros*, summit, and *sorion*, a little vessel.)

Macroscopic veins absent, microscopic veins present; frond flat, margin lobed; cystoc. with two groups sterile cells; carposp.

not in chains ; tetrasp. in single large sori below the apices of the frond.

Key.

Creeping over the attachment organs and stipes of	
<i>Laminaria</i>	<i>A. reptans</i> .
Thallus erect.....	<i>A. uncinatum</i> .

A. uncinatum Kylin (*Nitophyllum uncinatum* J. G. Agardh). Lat. *uncinatus*, furnished with hooks.—Thallus dark red, 3–6 cm. long, surface traversed by microscopic, irregularly dichotomous veins ; frond cleft from the base, irregularly di-trichotomous, sometimes pinnate ; segments 2–4 mm. broad or less, sometimes linear. Tetrasp. in roundish sori.

Very rare ; widely distributed.

A. reptans Kylin (*Nitophyllum reptans* Crouan). Lat. *reptare*, to creep.—Thallus bright red, membranaceous, monostromatic,

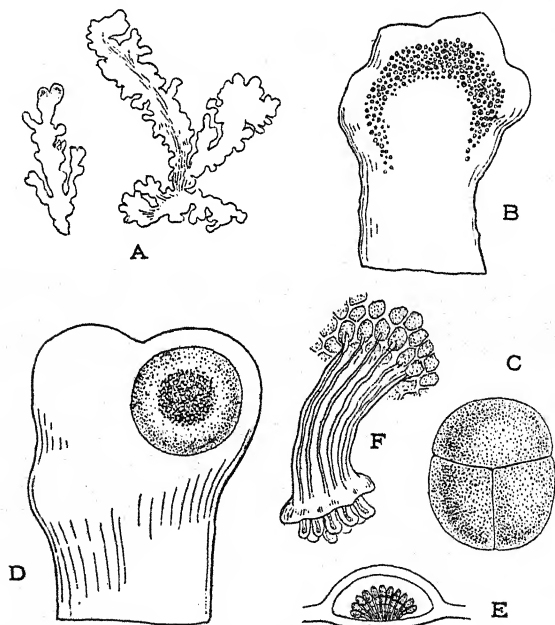


Fig. 199.—*Acrosorium reptans* Kylin. A. Plant ($\times \frac{2}{3}$) ; B. Portion bearing tetrasp. ($\times 6$) ; C. Single tetrasporang. ($\times 300$) ; D. Frond with cystocarp ($\times 6$) ; E. (After Crouan) section of a cystocarp ($\times 90$) ; F. Rhizoidal attachment processes ($\times 6$).

traversed by microscopic anastomosing veins ; frond dichotomously divided, lobes rounded, more or less procumbent, attached

by rhizoidal processes. Cystoc. solitary, near the apices (?); tetrasp. in sori fringing the rounded lobes.

Creeping over the attachment organs and stipes of *Laminaria*. Rare; widely distributed.

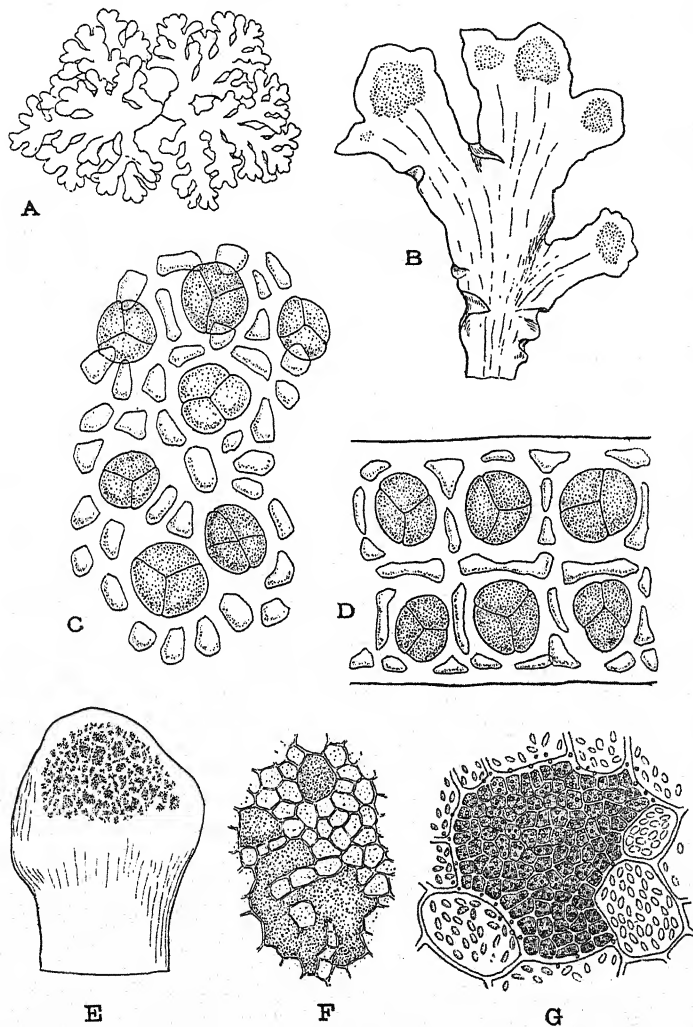


Fig. 200.—*Rhizoglossum thysanorhizans* Kylin. A. Plant ($\times 1$); B. Portion bearing tetrasp. ($\times 4$); C. Surface view of frond with tetrasp. ($\times 300$); D. Trans. sect. of frond with tetrasp. ($\times 300$); E. Tip of frond with anth. ($\times 6$); F. Surface view of the same ($\times 250$); G. The same ($\times 750$).

9. RHIZOGLOSSUM Kylin

(Gr. *rhiza*, a root, and *glossa*, a tongue.)

Thallus monostromatic when young, more or less dichotomously branched, macroscopic veins absent, microscopic veins present. Tetrasp. in irregularly spherical or elliptical sori below the apex of the thallus, tetrahedral; cystoc. distributed on the surface of the thallus, carposp. in chains.

R. thysanorhizans Kylin (*Nitophyllum thysanorhizans* Holm., non *N. venulosum* Zan.) Gr. *thusanos*, a tassel, and *rhiza*, a root. —Frond 2.5–5 cm. in length, much branched; branches between pinnate and furcate, slightly dilated upwards, the terminal segments generally 2-lobed, one lobe shorter and smaller than the other; fronds fringed with minute cellular processes developing rhizoid-like structures at their apices by which the plant adheres to other algæ; cells polygonal, becoming smaller and quadrate at the margin of the frond. Frond traversed by a network of veins, each formed of a single row of narrow, somewhat cylindrical cells. Tetrasp. collected into definite rounded sori in the apices of the ultimate segments; antherid. in similar position to tetrasp.

Very rare; Cornwall.

10. GONIMOPHYLLUM Batt.

(Gr. *gonimos*, productive, and *phyllon*, a leaf.)

Thallus consisting of groups of leafy fronds arising from a wart-like prominence formed of articulated endophytic filaments with a gelatinous investment. Leafy fronds flat, simple, or lobed and lacinated, composed of a single layer of cells at the margins and two or more layers at the portions occupied by reproductive organs. Tetrasp. cruciate, maturing first at the base of the frond.

Procarp and cystoc. somewhat resembling *Nitophyllum*, though the procarp are more numerous and prominent than in that genus and the speriferous filaments of the cystocarps more crowded.

G. Buffhami Batt. After T. Buffham, British algologist. —Fronds 1.5 to 3 mm. diam., arising in groups of 2 or 4 from each basal cushion. Tetrasp. and antherid. sori occupying the entire frond with the exception of a narrow margin.

Parasitic on *Nitophyllum laceratum*. Rare; England and Galway.

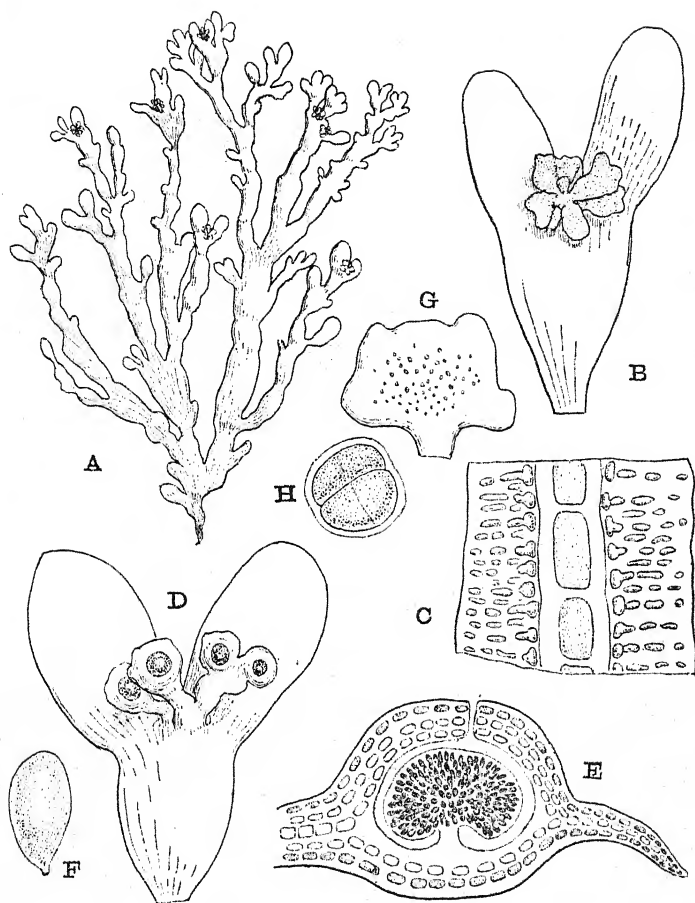


Fig. 201.—*Gonimophyllum Buffhami* Batt. A. Plant of *Nitophyllum laceratum* bearing tufts of *Gonimophyllum* in the clefts of the thallus ($\times \frac{3}{5}$); B. Antheridial plant on *Nitophyllum* ($\times 6$); C. Trans. sect. of same ($\times 300$); D. Cystocarpic plant on host ($\times 6$); E. Trans. sect. cystocarp ($\times 35$); F. single carpospore ($\times 300$); G. Portion of tetrasporic thallus ($\times 14$); H. Tetrasporang. ($\times 300$).

11. **PHYCODRYS** Kütz.

(Gr. *phucos*, a seaweed, and *drus*, an oak tree.)

Thallus leafy, monostromatic, except at the midrib, with marginal growth, irregularly bushy or lobed, mid-rib present; lateral veins opposite, microscopic veins doubtful or absent.

Cystoc. scattered on the surface of the thallus, carposp. borne in chains; tetrasp. scattered in the thallus or in small marginal patches.

P. rubens Batt. (*Delesseria sinuosa* Lamour.). Lat. *rubens*, reddish.—Thallus stipitate, stipe elongated, continuing throughout the length of the frond as a conspicuous mid-rib; lateral

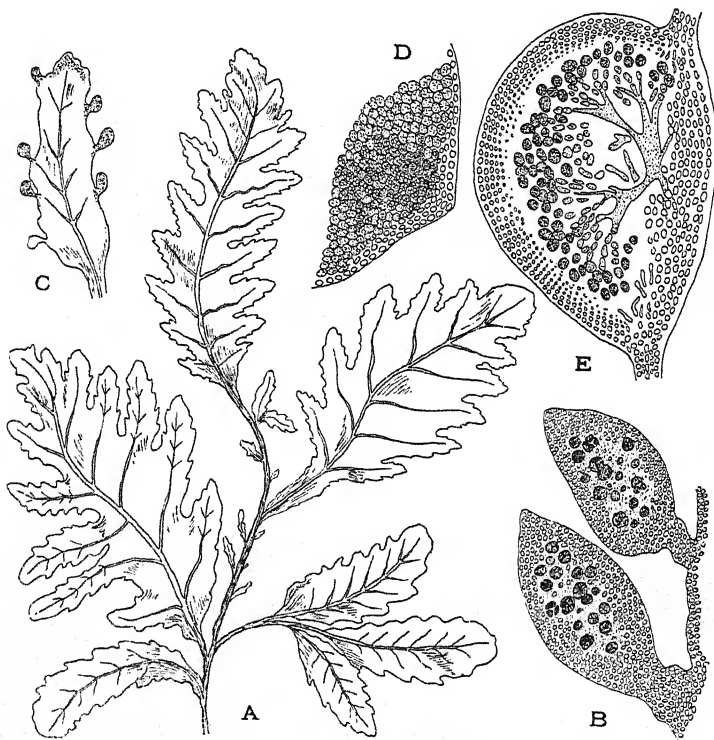


Fig. 202.—*Phycodrys rubens* Batt. A. Plant ($\times \frac{3}{2}$); B. Tetrasp. on older serrate thallus ($\times 60$); C. Antherid. on lobed serrations ($\times 3$); D. Surface view of tip of antheridial serration ($\times 60$); E. Trans. sect. of cystocarp ($\times 60$).

veins opposite, themselves bearing opposite branchlets. Frond purplish crimson or lake, leaf-like, membranaceous, oblong or obovate, deeply sinuated or pinnatifid, 10–15 cm. by 2.5–10 cm.; serrations sometimes reaching the mid-rib, so that the frond becomes compound; margin slightly dentate or much divided, forming slender elongated processes. Cystoc. solitary, on the veins or on small leaflets arising from the vein, depressed;

tetrasp. in oblong or linear marginal sori, formed at the apices of the lateral veins, often confined to the slender marginal processes.

Epiphytic on the stipes of *Laminaria*, also in deep water. Common; widely distributed.

var. *quercifolia* Turn. Laciniae of the frond rounded, margins naked. Rather rare; S. England and Scotland.

var. *lingulata* J. G. Agardh. Individual segments elongated and spatulate. Rare; Argyle.

12. ERYTHROGLOSSUM J. G. Agardh

(Gr. *eruthros*, red, and *glossa*, a tongue.)

Thallus small, flat, mid-rib absent or indefinite, lateral veins absent; monostromatic in the leafy parts, polystromatic in the mid-rib, proliferous from the margin. Tetrasp. in elongated sori near the margin of the thallus; cystoc. scattered.

E. Sandrianum Kylin (*Nitophyllum Sandrianum* Zan.) After E. Sandri, Italian botanist.—Often tufted, rosy red,

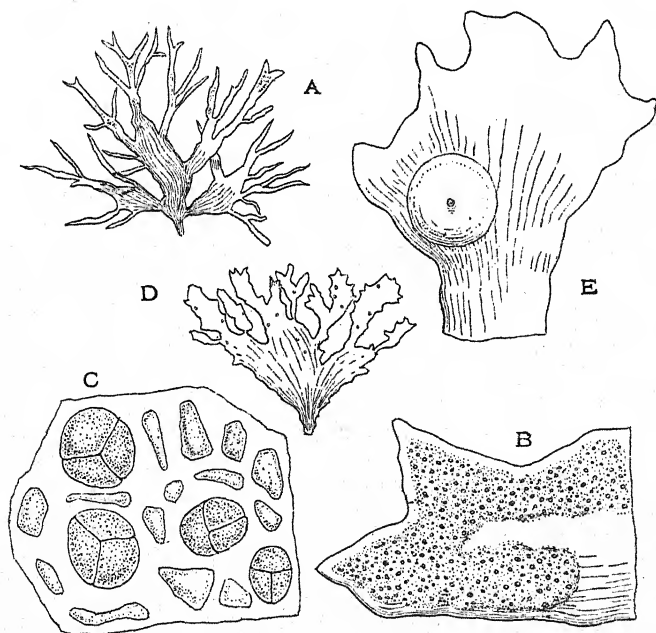


Fig. 203.—*Erythroglossum Sandrianum* Kylin. A. Tetrasporic plant ($\times \frac{3}{4}$); B. Portion of the same showing tetrasporang. in a sorus ($\times 12$); C. Surface view of thallus with tetrasporang. ($\times 300$); D. Cystocarpic plant ($\times \frac{3}{4}$); E. Portion of the same with cystocarp ($\times 12$).

2-5 cm. high, shortly stipitate, slightly ribbed at the base, irregularly pinnate by proliferations from the margin of the thallus; segments usually 2-4 mm. broad, sometimes themselves bearing a second series of proliferations, apices pointed, margin dentate between the proliferations. Tetrasp. near the margins of the larger segments.

Very rare; Somerset and Devon.

13. *POLYNEURA* Kylin

(Gr. *polus*, many, and *neuron*, a nerve.)

Thallus shortly stipitate, leafy, elliptical or rounded, irregularly bushy or lobed, mid-rib absent, veins more or less palmate,

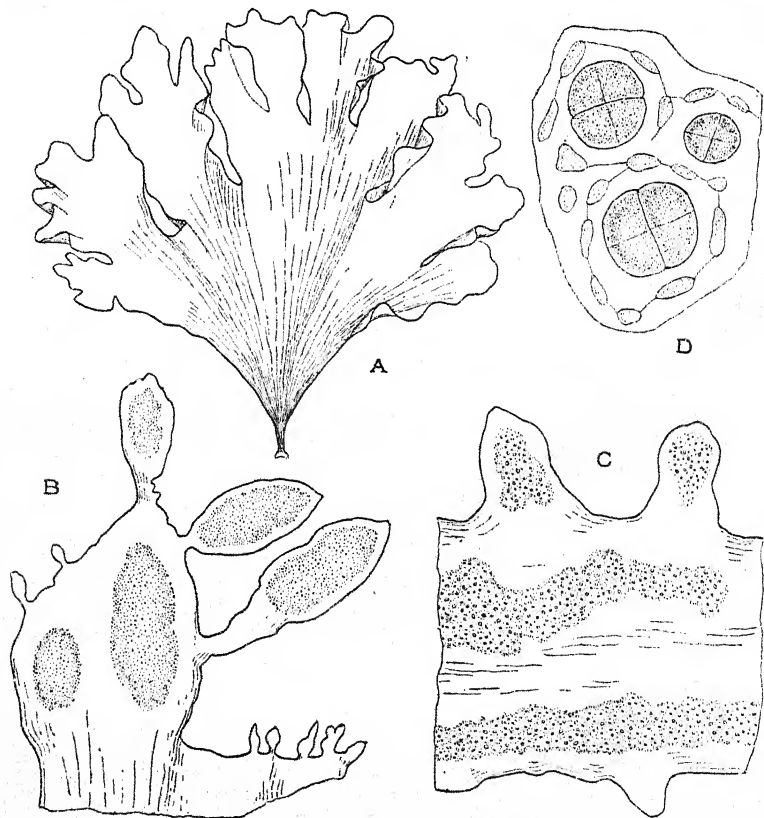


Fig. 204.—*Polyneura Gmelini* Kylin. A. ($\times \frac{2}{3}$); B. Portion showing tetrasporang. in linear sori on marginal proliferations ($\times 18$); C. Frond showing linear sori ($\times 25$); D. Surface view of thallus with tetrasporang. ($\times 300$).

irregular, anastomosing, microscopic veins in the young parts of the thallus; upper portion monostromatic, lower portion polystromatic. Cystoc. scattered on the upper surface of the thallus, carposp. borne in chains; tetrasp. in elongated sori on the upper surface of the thallus or near the margin.

1. Tetrasp. in linear sori on the margin of the frond *P. Gmelini* (1).
Tetrasp. sori not marginal..... 2.
2. Tetrasp. in minute, spherical sori scattered on the thallus..... *P. Hilliæ* (2).
Tetrasp. in subangular sori, scattered on the frond or elongated and linear, between the veins..... *P. litteratum* (3).

1. **P. Gmelini** Kylin (*Nitophyllum Gmelini* Grev.). After S. G. Gmelin, German botanist.—Fronde stipitate, stipe 0.5–1.25 cm. long, cylindrical and cartilaginous below, compressed above, expanding into a fan-shaped, deep lake, roundish frond, crisp, somewhat rigid, crackling in the fingers; variously cleft into broadly wedge-shaped segments, either jagged or subdivided dichotomously or cut into ribbons; veins more or less palmate, without conspicuous mid-rib, anastomosing; margin undulate. Cystoc. confined to the margin or scattered over the upper parts of the thallus, hemispherical, depressed; tetrasp. in linear sori, confined to the margin of the thallus.

On rocks and the larger algæ, near low-water mark and at greater depth. Not uncommon; S. and W. of England, N. and W. of Ireland; very rare in Scotland.

2. **P. Hilliæ** Kylin (*Nitophyllum Hilliæ* Grev.). After Miss Hill, English collector.—Fronde deep crimson, rosy when old, changing to orange in fresh water; thick, tender, semi-transparent, shortly stipitate, expanding into a roundish or flabellate frond, 10–30 cm. or more long, irregularly divided, sometimes nearly simple with a few marginal lobes, sometimes deeply cleft nearly to the base into a few broad segments, lobed at the margin, sometimes deeply cut into ribbons, proliferous at the margin, waved and crisped; veins more or less palmate, without conspicuous mid-rib, anastomosing. Cystoc. scattered, hemispherical; tetrasp. grouped in minute sori, roundish or oval, scattered over the frond.

On the shady sides of deep tide pools near low-water mark. Rather rare; S. England and W. Ireland; very rare in Scotland.

3. **P. litteratum** Kylin (*Nitophyllum litteratum* J. G. Agardh). Lat. *litteratus*, branded.—Stipe short, frond thick, tender, semi-transparent, palmate or pinnately lobed, veins dichotomous, anastomosing; marginal lobes cuneate-linear, with minute crenate undulations at the margin, more or less contracted at the base. Tetrasp. in angular sori formed in the middle of the frond, often elongated between the veins.

Very rare; Cornwall and Devon.

14. **CRYPTOPLEURA** Kütz.(Gr. *kruptos*, hidden, and *pleura*, a rib.)

Macroscopic veins present; cystoc. depressed, sphaeroidal, usually marginal or in marginal processes, possessing two groups of sterile cells; carposp. not in chains; tetrasp. in sori near the margin of the thallus or in marginal processes.

C. ramosum Kylin (*Nitophyllum ramosum* Batt., *Nitophyllum laceratum* Grev.). Lat. *ramosus*, branched.—Fronde purplish or brownish red, delicately membranaceous and very thin but somewhat tough, sessile or with a very short cartilaginous stem; thallus much divided, 10–20 cm. long, about as broad as long, the laciniae from 0.5–2.5 cm. or more broad; divisions usually dichotomous, very irregular, often proliferous and waved at the margin, obtuse, simple or repeatedly forked; lower part of the membrane traversed by branching, anastomosing veins. Cystoc. depressed, sphaeroidal, usually marginal or in marginal processes; tetrasp. in minute sori, spherical or elongated.

On rocks and stipes of *Laminaria* near low-water mark and at greater depth. Common; widely distributed.

var. **ciliifera** Kütz.—Marginal processes conspicuous. Not uncommon.

var. **lobata** Kütz. (*f. latifrons* Crouan). Broader than the type. Rather rare; Cornwall and Devon.

var. **uncinatum** Grev. (non *N. uncinatum* J. G. Agardh).—Ends of some of the branches sickle-shaped, cartilaginous. Rare; widely distributed.

Family II.—RHODOMELACEÆ

Thallus polysiphonous. Antherid. and procarps developed exterior to the main axis; cystoc. urn-shaped with an ostiole, usually shortly pedicellate; tetrasporang. tetrahedrally divided.

1. **BOSTRYCHIA** Mont.(Gr. *bostruchios*, a small curl.)

Fronde dark purple, compressed or filiform, dorsiventral, branching distichous or irregular; composed of a central siphon and several rows of elongated pericentral cells which may be surrounded by a band of smaller corticating cells; apices usually monosiphonous. Cystoc. terminal on the branches, ovate, with distinct ostiole; tetrasp. tetrahedral, in a double row in terminal fusiform stichidia.

B. scorpioides Kütz. (Gr. *skorpioeides*, scorpion-like).—Fronde 5–10 cm. long, in entangled tufts, filiform, flexuous, divided at irregular intervals into a few main branches, either alternate or subdichotomous, patent, having their apices spirally coiled; branches clothed throughout with patent or reflexed short, slender, alternate branchlets, apices more or less curled, bearing

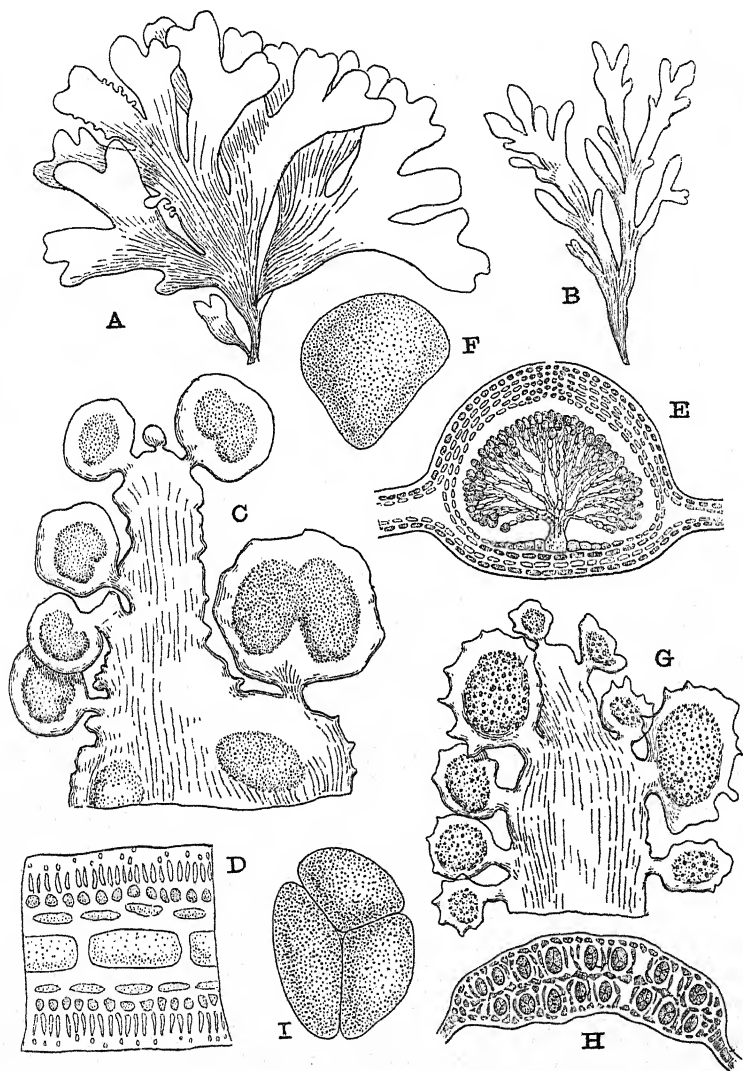


Fig. 205.—*Cryptopleura ramosum* Kylin. A. Typical plant ($\times 3$); B. Narrow form ($\times 3$); C. Portion showing antheridial sori ($\times 12$); D. Trans. sect. through antheridial sorus ($\times 300$); E. Trans. sect. cystocarp ($\times 33$); F. Single carpospore ($\times 300$); G. Portion showing tetrasporic sori ($\times 12$); H. Trans. sect. through tetrasporic sorus ($\times 33$); I. Single tetrasporang. ($\times 300$).

several series of ramuli of which the ultimate are subulate and thorn-like; pericentral cells of the thallus gradually smaller towards the periphery; articulations of the central siphon 4-5 times as long as broad.

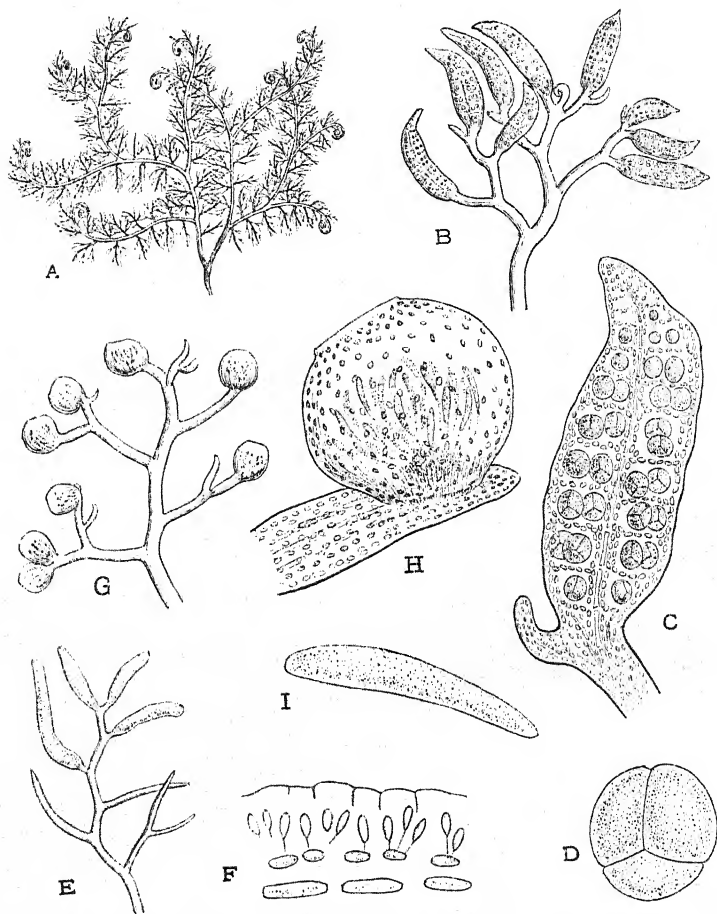


Fig. 206.—*Bostrychia scorpioides* Kütz. A. Plant ($\times \frac{3}{4}$); B. Thallus bearing tetrasp. ($\times 12$); C. Single tetrasporic stichidium ($\times 60$); D. Single tetrasporang. ($\times 200$); E. Portion bearing antheridial sori ($\times 12$); F. Trans. sect. of same ($\times 300$); G. Thallus bearing cystocarps ($\times 12$); H. Single cystocarp ($\times 60$); I. Carpospore ($\times 300$).

On muddy shores near high-water mark; at the estuaries of rivers; adhering to the roots and stems of flowering plants in salt-water ditches and marshes. Local; S. and E. England, Wales, Ireland and Channel Islands.

2. **RHODOMELA** C. A. Agardh(Gr. *rhodon*, a rose, and *melas*, dark.)

Fronds filiform or subcompressed, not attenuate at the base, inarticulate, much branched; composed of a monosiphonous axis, surrounded by a peripheral zone of elongated cells, bounded

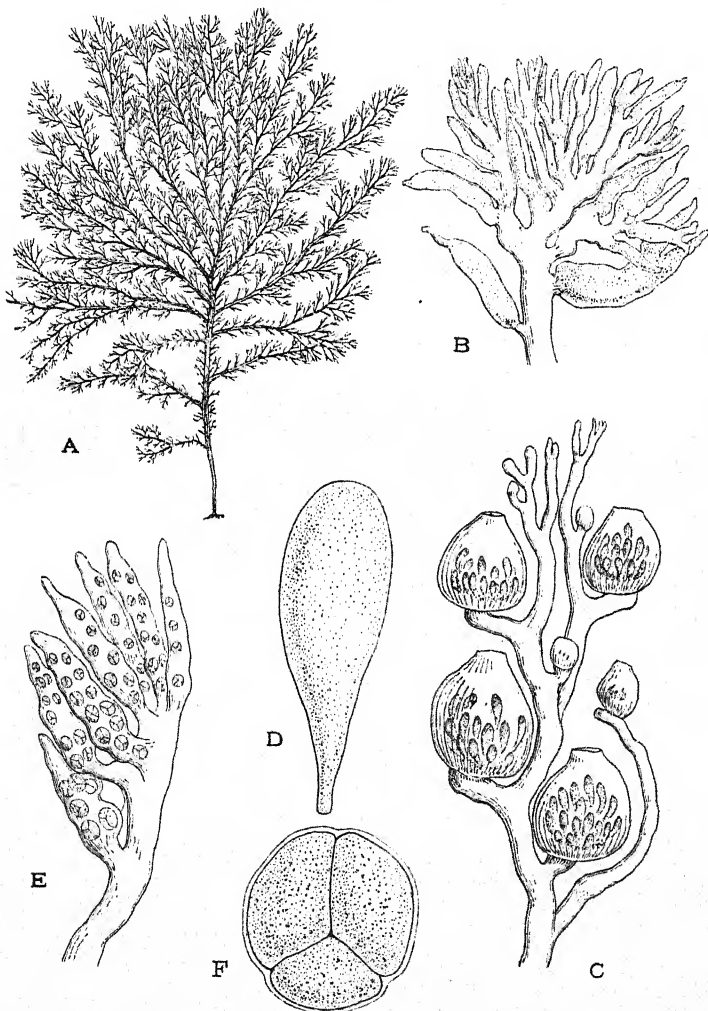


Fig. 207.—*Rhodomela subfusca* C. A. Agardh. A. Plant ($\times \frac{1}{3}$); B. Portion bearing antheridial sori ($\times 33$); C. Thallus bearing cystocarps ($\times 33$); D. Single carpospore ($\times 300$); E. Thallus bearing tetrasporic stichidia ($\times 33$); F. Tetrasporang. ($\times 300$).

by a band of small corticating cells. Cystoc. sessile or stipitate, with an apical ostiole and pyriform carposp.; tetrasp. tetrahedral in the ultimate branchlets.

Key.

Usually epiphytic, purplish brown, ramuli dense ... *R. lycopodioides*.
 Usually saxicolous or growing on shells, brownish red; ramuli less densely tufted than in *R. lycopodioides* *R. subfusca*.

R. subfusca C. A. Agardh. Lat. *suffusus*, somewhat brown.—Generally tufted, 7.5–30 cm. long, attenuate upwards, cylindrical, much branched. Branches irregularly divided, clothed with pinnated branchlets and subulate, simple, scattered or tufted ramuli. In winter secondary branches fall off, leaving the main branches and remains of ramuli. Frond brownish red, cartilaginous, very rigid in the branches, more flaccid in the ramuli, opaque; articulations not visible. Cystoc. borne in summer, ovate, sessile or stipitate, lateral on the branchlets; tetrasp. immersed in the swollen apices of the pinnules or in special stichidia, produced all the year round.

On rocks and shells, in pools between the tide-marks, more rarely epiphytic. Common; widely distributed.

var. **gracilior** J. G. Agardh.—More slender than the type. Rare; Berwick, Bute and Kirkwall.

var. **firmior** J. G. Agardh.—Frond robust, no tetrasp. in the finer ramuli. Rare; Torquay, Falmouth, Kirkwall and Jersey.

R. lycopodioides C. A. Agardh. From *Lycopodium*, a genus of Pteridophyta, and Gr. *eidos*, like.—Frond purplish brown, cartilaginous in winter, soft in summer; 10–60 cm. long, attenuate upwards, cylindrical, filiform, tufted, simple or divided near the base into several long, simple branches, densely beset with slender, finely divided branchlets, mixed with the short, bristle-like remains of a former series, the whole clothed in summer with tufts of multifid ramuli. Cystoc. abundant on the summer ramuli, ovate, with terminal ostiole and pyriform carposp.; tetrasp. tetrahedral, embedded in clustered or racemose distorted ramuli, borne on the winter branchlets.

Usually epiphytic on the stipes of *Laminaria*. Common; Scotland, N. England and Ireland.

var. **laxa** Kjellm.—More lax than the type. Not uncommon; Berwick and Kirkwall.

3. ODONTHALIA Lyngb.

(Gr. *odous*, *odontos*, a tooth, and *thalia*, abundance.)

Fronds two-edged, plano-convex, distichous, with rudimentary midrib, margin alternately toothed, formed of oblong

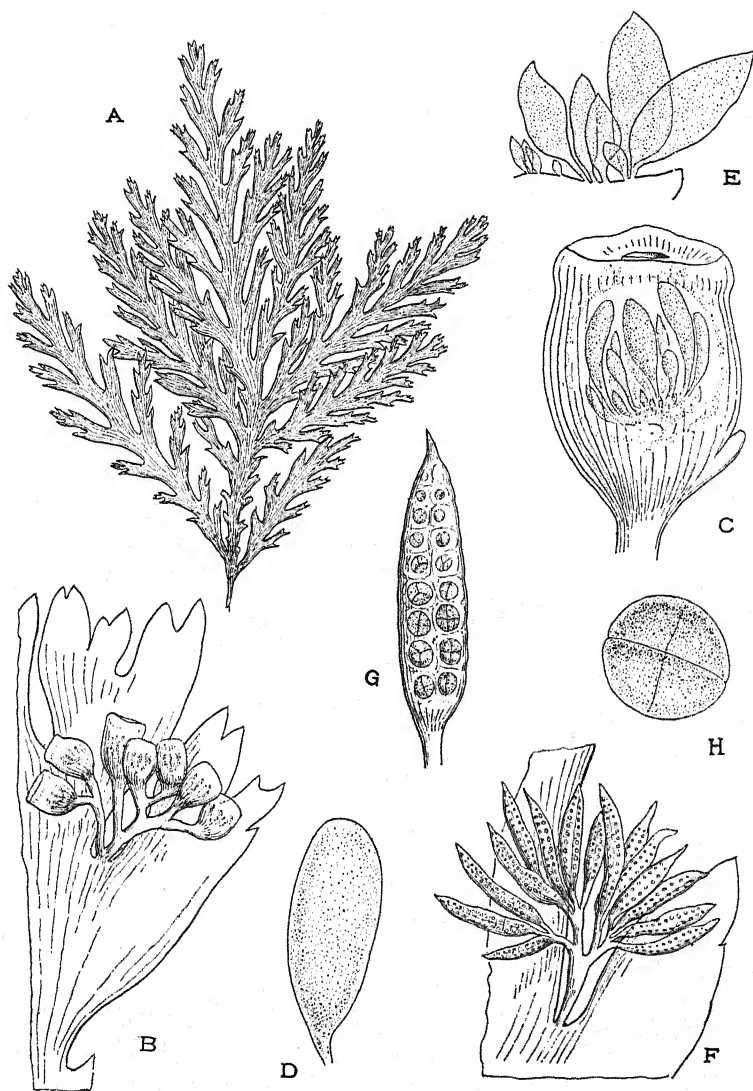


Fig. 208.—*Odonthalia dentata* Lyngb. A. plant ($\times \frac{2}{3}$); B. Portion of the frond with cluster of cystocarps ($\times 12$); C. Single cystocarp ($\times 120$); D. Single carpospore ($\times 300$); E. Cluster of the antheridial proliferations ($\times 12$); F. Group of tetrasporic stichidia ($\times 12$); G. Single tetrasporic stichidium ($\times 40$); H. Single tetrasporang. ($\times 150$).

internal cells and small, irregularly shaped, cortical cells; cystoc. on short, corymbose, stipitate branchlets, axillary or marginal; tetrasp. embedded in lanceolate stichidia, similarly placed.

O. dentata Lyngb. Lat. *dentatus*, toothed.—Fronds deep purplish red, more or less cartilaginous, tufted, 7.5–30 cm. long, much branched, irregularly pinnate, branches linear-oblong, deeply pinnatifid; midrib visible near the base, vanishing above; branchlets alternate, linear, entire below, alternately toothed above, the larger ones pinnatifid with toothed segments. Smell pungent. Cystoc. pitcher-shaped with very wide ostioles, borne on the margin or in the axils of the teeth; antherid. borne on leafy proliferations; tetrasp. in nearly colourless stichidia.

On rocks in the sea, perennial, fruiting in winter. Common; Scotland, N. England and Ireland.

4. LAURENCIA Lamour.

(After M. de Lalaurencie, French naturalist.)

Thallus cylindrical or compressed, linear, pinnately branched, apices obtuse; central siphon only visible at the apices of the branches; pericentral zone formed of elongated longitudinal cells, bounded by a single cell-layer of roundish compact cells; apical cell in a small depression, surrounded by dichotomous colourless hairs. Cystoc. urn-shaped, ovoid or spherical, sessile on the branches; tetrasp. embedded in the ramuli, tetrahedral.

Key.

- | | |
|---------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1. Thallus compressed, many times pinnate;
branches given off from the compressed edge
of the frond | <i>L. pinnatifida</i> (3). |
| Thallus cylindrical or subcompressed; branches
arising irregularly | 2. |
| 2. Purple or greenish yellow, cylindrical or sub-
compressed; branches and ramuli of main
branches erect, alternate | <i>L. cæspitosa</i> (2). |
| Purple, red, or yellowish red, cylindrical;
branches and ramuli patent, opposite..... | <i>L. obtusa</i> (1). |

1. **L. obtusa** Lamour.—Fronds pinkish or purple, sometimes yellowish red, cartilaginous, brittle, forming dense globose tufts, 7.5–15 cm. long, cylindrical, of equal diameter throughout, furnished with a simple axis, closely set throughout with patent or horizontal, often opposite lateral branches, diminishing in length from base to apex, giving the frond a pyramidal outline; branches spirally inserted, repeatedly pinnate; pinnæ opposite, patent, lower ones often short, middle ones longest, gradually shorter towards the tip, ultimate ramuli very short, obtuse, clavate, simple or bearing two or three small processes. Cystoc. and antherid. formed near the tips of the ramuli; tetrasp. embedded in the tips of the ramuli.

Usually epiphytic on other algæ between the tide-marks. Not uncommon; widely distributed.

var. **crucifera** Hauck.—Branches and ramuli opposite. Rare; Dorset.

var. **pyramidata** J. G. Agardh.—Shading into purple; ultimate ramuli fasciculate and corymbose. Rare; Cornwall and Dorset.

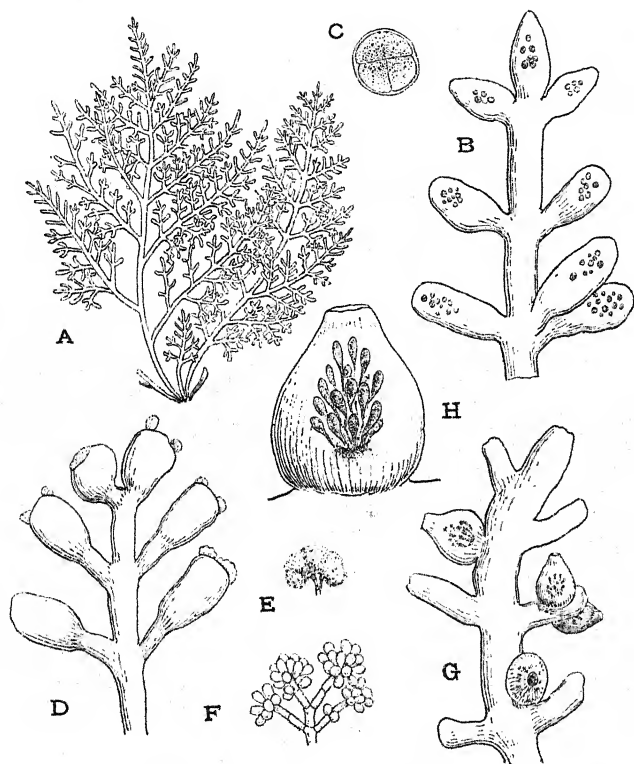


Fig. 209.—*Laurencia obtusa* Lamour. A. Plant ($\times \frac{1}{2}$); B. Frond with tetrasporic sori ($\times 10$); C. Single tetrasporang. ($\times 33$); D. Antheridial sori at tips of obtuse apices ($\times 10$); E. The same ($\times 33$); F. Portion of the same ($\times 300$); G. Frond with cystocarps ($\times 10$); H. Single cystocarp ($\times 33$).

2. **L. cæspitosa** Lamour. Lat. *cæspes*, a clump.—Fronds dark lurid purple, cartilaginous, densely tufted, 5–15 cm. long, of nearly equal breadth throughout, cylindrical or very slightly compressed, having a main central axis, set with numerous alternate or rarely opposite, erect branches, the lower being longest, giving the plant a pyramidal outline; branches repeatedly

pinnate, naked below, the divisions erect, blunt or truncate, the ultimate ramuli frequently several times divided at the apex. Cystoc. unknown; tetrasp. confined to the apices of the ramuli, tetrahedral.

On stones and shells between the tide-marks, rarely epiphytic. Common; widely distributed.

3. *L. pinnatifida* Lamour. Lat. *pinnatus*, feathered; *fidus*, cut.—Fronds varying with exposure to sun, from pale yellow to greenish olive or purple, cartilaginous; very variable in form, depending on its position with regard to low-water mark. Tufted, 2.5–30 cm. long, flattish, compressed or subcylindrical, the main axis undivided or cleft into several segments, furnished throughout with alternate, distichous branches of varying length, closely packed, with rounded axils; smaller branches pinnatifid or bearing a second or third series of branchlets, ultimate ramuli obtuse. Cystoc. sessile or very shortly stipitate, borne on the ramuli; spermatia produced in a cup-like structure at the apices of the ramuli; tetrasp. tetrahedral, immersed in the apices of the ramuli.

On rocks from extreme high-water mark to beyond the limit of low water. Common and abundant; widely distributed.

var. *osmunda* Harv.—Fronde flat, generally undivided; ramuli short and multifid. Common.

var. *litoralis* Harv.—Dwarf, greenish olive; frond flat, broad, tapering below; ramuli short, emarginate.

This species often has a hot biting taste, and was formerly eaten in Scotland under the name of Pepper Dulse.

5. HALOPITYS Kütz.

(Gr. *hals*, the sea, and *pitus*, a pine tree.)

Thallus cylindrical, erect, composed of one central and 5 pericentral siphons, bounded by a band of corticating cells, becoming smaller near the periphery; branches and ramuli recurved near their apices; ramuli at almost regular intervals, in pairs, one on each side of an articulation. Cystoc. urceolate, pedicellate on the ramuli; tetrasporang. in two longitudinal rows in the ramuli.

H. incurvus Batt. (*Rytiphloea pinastroides* C. A. Agardh).—Fronds dark red, cartilaginous and tough, very rigid when dry; tufted, 10–25 cm. long, cylindrical, much branched, bushy; main branches alternate or sub-dichotomous, clothed in their lower part with short, subulate, simple ramuli, much branched above; the branches pectinate with a double set of subulate ramuli on their upper side, generally in pairs, but sometimes irregular; ramuli erect with straight or hooked apices, somewhat attenuate below; articulations visible, much shorter than broad. Cystoc. ovate, on longish pedicels, borne on the inner faces of the ramuli;

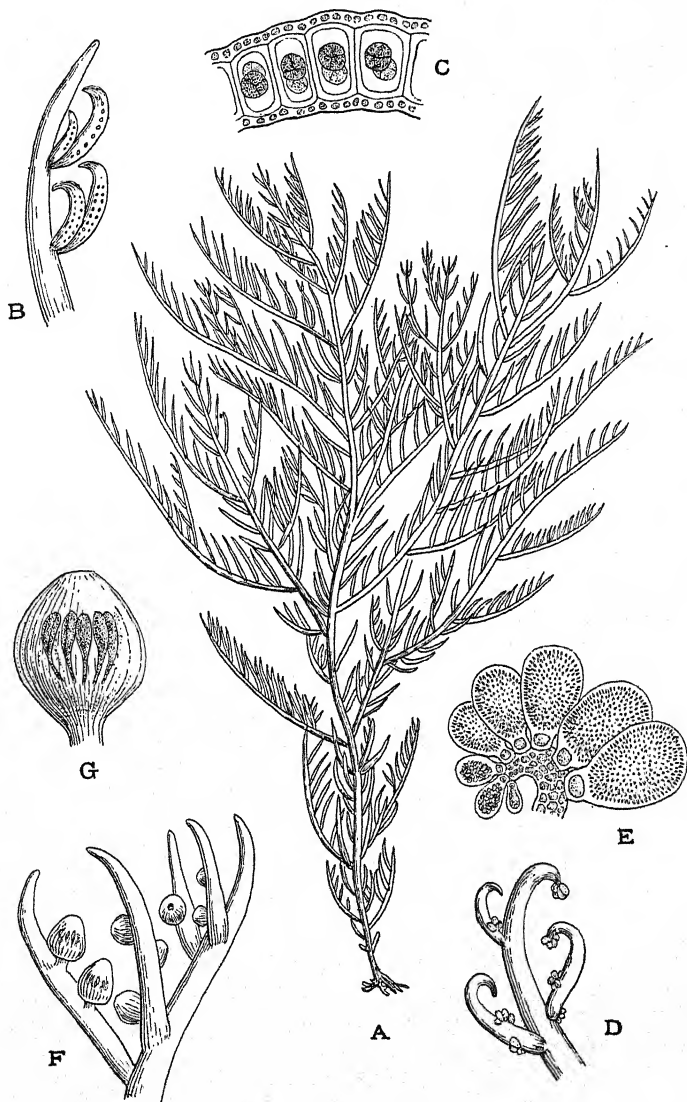


Fig. 210.—*Halopitys incurvus* Batt. A. Plant ($\times \frac{2}{3}$); B. Tetrasporic stichidia ($\times 10$); C. Trans. sect. of same ($\times 66$); D. Antheridial sori ($\times 10$); E. The same ($\times 66$); F. Frond with cystocarps ($\times 10$); G. Cystocarp ($\times 33$).

tetrasp. tetrahedral, borne on separate plants in lanceolate, shortly stipitate stichidia.

On submarine rocks near low-water mark; perennial, clothed in winter with broken remains of old ramuli. Not uncommon; S. England and the Channel Islands.

6. CHONDRIA C. A. Agardh

(Gr. *chondros*, cartilage.)

Thallus cylindrical, much branched, composed of one central and 4-6 pericentral siphons, surrounded by a band of corticating cells becoming smaller near the periphery. Cystoc. sessile, ovate, with distinct ostiole, carposp. pyriform; antherid. borne in short disc-like branchlets, covering both surfaces except at the margin; tetrasp. tetrahedral, borne in club-shaped branchlets.

Key.

- | | |
|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1. Ramuli very slender, setaceous, attenuate at both extremities | <i>C. tenuissima</i> (1). |
| Ramuli attenuate at the base, clavate or elongated, truncated at the apex | 2. |
| 2. Thallus iridescent, blue or rarely yellowish; ramuli long, linear, attenuate below, truncated above, often very curved..... | <i>C. cœrulescens</i> (3). |
| Thallus red or purple, ramuli short and thick, ovoid, clavate or more elongate, erect or slightly curved | <i>C. dasyphylla</i> (2). |

1. *C. tenuissima* C. A. Agardh (*Laurencia tenuissima* Harv.). Lat. *tenuissimus*, very thin.—Fronds pale pinkish purple, fading in the sun to yellowish, between cartilaginous and gelatinous, densely tufted, 15-25 cm. long; branches attenuate upwards; main axis simple or divided into 4 or 5 principal parts, each closely set with slender, alternate, erect or somewhat patent undivided branches, sometimes bearing a second series.; the whole densely clothed with setaceous simple ramuli, attenuate at each extremity. Cystoc. ovate, subsessile, borne profusely on the ramuli; antherid. in short disc-like apical branchlets; tetrasporang. globose, scattered in the ramuli.

On rocks and stones, generally in shallow pools, between the tide-marks. Rare; widely distributed.

2. *C. dasyphylla* C. A. Agardh (*Laurencia dasyphylla* Grev.). Gr. *dasus*, shaggy, and *phyllon*, a leaf.—Fronds red or purple, cartilaginous when fresh, cylindrical, filiform, 10-30 cm. long, usually with an undivided or once-forked main axis, closely set with lateral irregularly placed branches, the long lower ones giving the plant a pyramidal outline; branches bearing a second or third series of smaller branchlets, the last series being furnished with short, patent, club-shaped, obtuse ramuli, much attenuate at

the base ; articulations visible in the young branches and ramuli. Cystoc. sessile on the smaller branches ; tetrasp. immersed in the ramuli.

On stones and shells in pools near low-water mark, often on a sandy or muddy bottom. Common ; widely distributed.

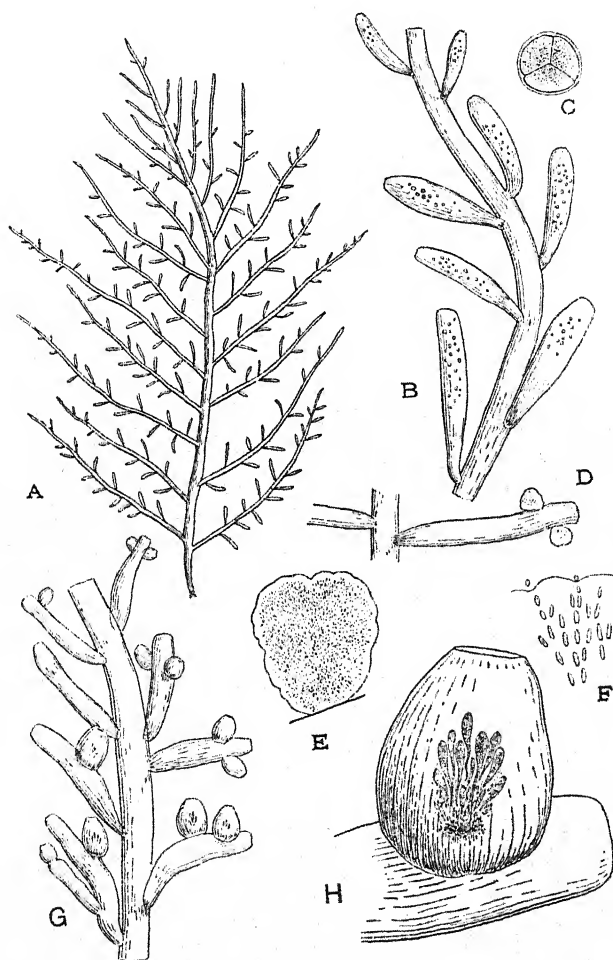


Fig. 211.—*Chondria dasyphylla* C. A. Agardh. A. Plant ($\times \frac{2}{3}$); B. Portion bearing tetraspores ($\times 6$); C. Tetrasporang. ($\times 33$); D. Portion of frond with antheridial sorus ($\times 6$); E. Antheridial sorus ($\times 33$); F. Section of same ($\times 300$); G. Frond with cystocarps ($\times 6$); H. Cystocarp ($\times 33$).

3. *C. cærulescens* J. G. Agardh. Lat. *cærulescens*, becoming dark blue.—Thallus iridescent blue or rarely yellowish, shot with blue when fresh, almost black when dry, 5–20 cm. long; formed of slender branches, scarcely attenuate at the apices; clothed in their upper and middle parts with linear ramuli, attenuate at the base, truncated at the apices, often very long and curved.

Very rare; Sussex and Suffolk.

7. POLYSIPHONIA Grev.

(Gr. *polus*, many, and *siphon*, a tube.)

Thallus branched, bearing numerous ramuli which in perennial forms are shed annually before the winter, the plant being re-clothed in spring. Antherid. produced on filamentous hairs on the tips of the branches and ramuli; cystoc. on the ramuli or the branches, urn-shaped, with an ostiole at the top. Attached to the substratum by numerous rhizoids.

The species fall into two groups—

I Ecorticate.

II Corticate.

The thallus of the ecorticate forms consists solely of siphons—that is, of cells extending the whole length of the articulation. In the corticate forms, in addition to the siphons, cells are present at the periphery of the thallus, shorter than the siphons and smaller in diameter. These form a mosaic extending over the whole plant or occurring on the lower parts only. The thallus consists then of one central siphon and a band of primary pericentral siphons numbering from 4 to 20 or even more, which may be surrounded by alternating bands of smaller siphons and bounded externally by one or more rows of cells. The pericentral siphons are usually parallel to the main axis, but are spirally placed in some species.

Key.

- | | |
|-------------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Axis consisting of 4 primary pericentral siphons, with or without cortication | 19. |
| More than 4 | 2. |
| 2. Axis consisting of 5 primary siphons | 3. |
| More than 5 | 4. |
| 3. Articulations 3 or 4 times longer than broad in lower parts of axis; siphons spirally placed | <i>P. Richardsoni</i> (11). |
| Articulations shorter than their breadth near the base; siphons irregular | <i>P. variegata</i> (23). |
| 4. Axis consisting of 6 primary pericentral siphons, with or without cortication | 8. |
| More than 6 | 5. |
| 5. Axis consisting of 7 primary pericentral siphons, with or without cortication | 8. |
| More than 7 | 6. |
| 6. Axis consisting of 8–11 primary pericentral siphons, with or without cortication | 7. |
| More than 11 | 11. |
| 7. Zone of cells present in older parts, outside primary siphons..... | 8. |

- Plant ecorticate..... 9.
8. Ramuli slender and regularly distributed over the younger branches *P. variegata* (23).
 Ramuli borne close together, giving plant a tufted appearance *P. Brodiaei* (20).
P. nigra (6).
9. Pericentral siphons spirally curved..... 10.
 Pericentral siphons straight *P. furcellata* (8).
P. fatidissima (21).
10. Plant bright brick-red 12.
 Plant dark brownish red 16.
11. Axis consisting of 12-14 primary pericentral siphons, with or without cortication *P. nigra* (6).
 More than 14 13.
12. Pericentral siphons spirally curved..... *P. obscura* (9).
 Pericentral siphons straight..... 14.
13. Maximum height of plant 3 cm. *P. subulifera* (13).
 Plant more than 3 cm..... 15.
14. Colour bright brick-red when fresh..... *P. simulans* (12).
 Plant dark or blackish *P. nigrescens* (22).
15. Central siphon small *P. obscura* (9).
 Central siphon occupying about $\frac{1}{3}$ diam. of thallus in transverse section 17.
16. Filaments decumbent; plant not more than 3 cm. high *P. fastigiata* (7).
 Plant erect, more than 3 cm. high..... 18.
17. Usually parasitic on *Ascomyllum nodosum*, and containing conspicuous central siphon *P. nigrescens* (22).
 Plant not parasitic *P. opaca* (10).
18. Zone of corticating cells present outside the primary siphons at extreme base of main axis 20.
 Axis consisting solely of one central and about 20 pericentral siphons, ecorticate throughout 27.
19. Plant ecorticate 22.
 Plant corticate 21.
20. Siphons spirally curved in principal branches *P. macrocarpa* (2).
 Siphons in principal branches straight..... 23.
21. Plants gelatinous, occurring in tufts about 3 cm. in height *P. spiralis* (4).
 Plant not gelatinous..... *P. fibrata* (16).
P. urceolata (5).
22. Articulations one or $1\frac{1}{2}$ times as long as broad 24.
 Articulations 6-8 times as long as broad 25.
23. Plant deep full red 26.
 Plant dark reddish brown or greyish *P. fibrata* (16).
24. Articulations 4-6 times as long as broad *P. insidiosa* (1).
 Articulations less than 4 times as long as broad *P. insidiosa* (1).
25. Ramuli dichotomously branched..... *P. rhunensis* (3).
 Ramuli alternate or unilateral..... *P. fibrillosa* (17).
26. Plant greyish. Articulations 3 or 4 times as long as broad 28.
 Reddish brown. Articulations 2 or 3 times as long as broad *P. elongata* (14).
27. Plant pale straw-coloured or brownish 29.
 Plant dark red 30.
28. Ramuli tapering at base and apex 31.
 Ramuli not tapered at extremities *P. fibrata* (16).
29. Plants tufted from the base *P. spinulosa* (18).
 Plants with conspicuous main axis..... *P. elongella* (15).
30. Ramuli dichotomous *P. violacea* (19).
 Ramuli alternate *P. violacea* (19).
31. Axils of lower branches markedly obtuse *P. violacea* (19).
 Axils of lower branches acute *P. violacea* (19).

I. Ecorticate species.

A. Four primary pericentral siphons.

1. *P. insidiosa* Crouan. Lat. *insidiosus*, deceitful. Plants greyish brown, becoming black in drying, in tufts, branched from the base; branching pseudo-dichotomous, ramuli alternate or unilateral. Diameter of the branches variable, attenuate upwards. Lower articulations and those of the ramuli, once or twice as long as broad, those of the upper parts of the main branches 3-4 times their breadth. Tetrasp. in distorted ramuli; antherid. cylindrical, obtuse at the apices; cystoc. ovate, sessile on the ramuli.

On muddy rocks, large stones, and on other algæ at extreme low-water mark. Very rare; Yarmouth to Torquay.

2. *P. macrocarpa* Harv. (*P. pulvinata* Harv. and *P. sertularioides* Holm. & Batt.).—Gr. *makros*, large, and *karpos*, fruit. Plants dark reddish brown, in roundish tufts rarely more than 2.5 cm. high; main branches showing marked tendency to pseudo-dichotomy; ramuli unilateral or alternate, generally backwardly directed. Siphons 4 pericentral, and tetrasp. intercalary in the ramuli; cystoc. stalked, urn-shaped, elongated at the apex.

On rocks between the tide-levels and creeping in the sand. Common; widely distributed.

3. *P. rhunensis* Thur. From "le Rhun," a roadway between the mainland of France and the isle of Tatihou.—Plants reddish brown; in tufts, 8-10 cm. high, branched from the base; branches alternate, attenuate upwards, clothed with ramuli. Articulations 2-3 times as long as broad, diminishing in length near the attachment organ and in the ramuli. Tetrasp. borne in the ramuli; antherid. on the dichotomising fibrillæ, cylindrical, obtuse, rounded at their apices; cystoc. shortly stalked, almost sessile, ovate, with short ostiole, frequently sinuous.

On rocks and stones near low-water mark. Rare; Cornwall and Devon.

4. *P. spiralis* Batten.—Plants gelatinous, in tufts rarely more than 2.5 cm. high, siphons 4 pericentral round large central, pericentral siphons spirally placed in the main branches. Articulations 3 times as long as broad, diminishing in length in the ramuli and near the attachment organ.

On rocks and groins near low-water mark. Dorset.

5. *P. urceolata* Grev. Lat. *urceolus*, a little pitcher. Plants deep red, tufted, from 15-23 cm. long. Branching pseudo-dichotomous in the main branches; ramuli alternately branched and arising alternately, often flexed; siphons 4 pericentral round minute central; articulations 3-5 times longer than broad in the principal branches, approximately equal to their breadth

in the lower parts of the plant and rather shorter in the ramuli. Tetrasp. in the upper parts of the ramuli, usually extending to the tip; antherid. elongated, narrow and stalked on the tips of lateral ramuli; cystoc. shortly stalked, elongated, on the upper branches and ramuli.

On rocks, limpet shells and larger algæ, particularly *Laminaria*, near low-water mark. Common.

var. **patens** J. G. Agardh.—Less branched than the type, with shorter articulations; branches beset with short re-curved ramuli. Widely distributed.

var. **formosa** J. G. Agardh (*P. formosa* Suhr).—Filaments sub-flaccid, upper branches sub-corymbose and secund. Not uncommon; widely distributed.

var. **comosa** J. G. Agardh (*P. stricta* Grev.).—Fronds densely tufted, setaceous, flaccid, dichotomous; branches and ramuli straight, erect; axils acute, upper articulations 4–5 times longer than broad; cystoc. ovate, sessile. Not uncommon.

B. More than four primary pericentral siphons.

6. **P. nigra** Batt. (*P. atro-rubescens* Grev.). Lat. *niger*, black. Plants attaining a length of 30 cm., dark red when young, later becoming black, main axis often pseudo-dichotomously branched, smaller branches arising alternately, the whole being clothed with short spine-like ramuli. Small branches and ramuli tapering at the base and apex. Siphons 8–14 pericentral and large central. Articulations 2–3 times as long as broad in the principal parts of the main branches; pericentral siphons spirally curved. Tetrasp. intercalary in origin, in swollen ramuli; cystoc. sessile or very slightly stalked and broadly ovate with a large open ostiole.

On rocks, stones and shells such as *Pecten maximus*, only exposed at low-tide or obtained by dredging. Not common; widely distributed.

7. **P. fastigiata** Grev. Lat. *fastigium*, a gable.—Plants dark reddish brown, densely tufted, 7 or 8 cm. in height, on *Ascophyllum nodosum*. Branching dichotomous, apices outspread. Siphons 12–24 pericentral round large central; articulations shorter than broad, the contents of the central siphon being conspicuously dark. Parasitic, obtaining food from the host by numerous penetrating rhizoids. Tetrasp. in swollen terminal branches; antherid. bright yellow, in elongated clusters at the tips of the branches in winter and spring; cystoc. sessile, egg-shaped, replacing one of the apical dichotomous branches.

Very common wherever *Ascophyllum* occurs.

8. **P. furcellata** Hook. Lat. *furcilla*, a little fork.—Plants 12–14 cm. high; brick-red when fresh, with well-marked central axis and numerous widely spread lateral branches. Siphons 8 or 9 pericentral, and one small central. Tetrasp. intercalary, borne in distorted ramuli. Cystoc. ovate and sessile.

In deep water. Rare; S. England and Ireland.

var. **forcipata** J. G. Agardh (*P. turgidula* Holm.).—Upper branches dichotomous, with the apices converging. Very rare; Falmouth.

9. **P. obscura** J. G. Agardh.—Forming low tufts 1–3 cm. high, 12–18 pericentral siphons round large central. Tetrasp. intercalary, formed spirally in much-branched filaments.

In tufts on sheltered rocks, on the attachment organs of Fuci, and on smaller algæ. Very rare; S. England and Channel Islands.

Distinguishable among British species by diminutive habit and large number of siphons.

10. **P. opaca** Zanard.—Plants from 1–9 cm. high, ramuli short and spine-like and closely set on the smaller branches; siphons 20 or more pericentral round large central. Tetrastorang. intercalary, not always occupying successive articulations of the ramulus; Cystoc. ovoid, sessile on the ramuli.

Occurring between the tide marks. Rare; Guernsey.

11. **P. Richardsoni** Hook. After Dr. (afterwards Sir John) Richardson.—Siphons 5, round a smaller central siphon. Pericentral siphons spirally placed. Very rare; Kirkcudbright.

12. **P. simulans** Harv. Lat. *simulare*, to imitate.—Plants tufted from the base; branches arising alternately, sparsely clothed with irregularly pinnate ramuli, tapering sharply at the apex; siphons 12 pericentral round a central one of diam. equal to $\frac{1}{3}$ – $\frac{2}{3}$ the radius of the filament. Tetrasp. intercalary; cystoc. sessile, ovate, on the smaller branches. Rigid when fresh, but adhering to paper after immersion in fresh water. Much darker in colour than *P. subulifera*.

Occurring near low-water mark, usually on thin-bedded and eroded schists. Rare, but widely distributed.

13. **P. subulifera** Harv. Lat. *subula*, an awl, and *fero*, I bear.—Tufted from the base, deep red when fresh, as much as 20 cm. long, branched at intervals, beset with short spine-like ramuli; siphons 12–13 pericentral round a small central; articulations 2–3 times as long as broad, diminishing in the smaller branches and ramuli. Tetrastores in distorted ramuli.

Rarely found except by dredging, occurring chiefly on Nullipore banks. Very rare; widely distributed.

Distinguished from *P. simulans* by larger size, lighter colour, and difference in habitat.

var. **Templetoni** Harv.—More slender than the type, articulations 2 or 3 times longer than broad. Belfast Bay.

II. Corticate species.

A. 4 primary pericentral siphons.

14. **P. elongata** Harv.—Plants usually solitary, reddish brown, very dark in older parts; ramuli crimson, 15–30 cm. long,

with well-marked main axis. Branches naked during the winter, clothed in spring with dense mass of ramuli, attenuate at bases and apices; main branches cartilaginous, ramuli gelatinous; siphons 4 primary pericentral, alternating with which on the outside are 4 secondary. Surrounding these in the older parts 8 tertiary siphons occur, bounded by a zone of corticating cells. Attached by an expanded disc. Tetrasp. in lateral and terminal ramuli; cystoc. on small branches, sessile or very slightly stalked, ovate but tending to be elongated.

On rocks, stones and shells in pools and muddy bays between the tide-levels and in 5-10 fathoms of water. Common; widely distributed.

var. *rosea* J. G. Agardh (*P. rosea* Grev., *P. elongata* var. *sanguinolenta* Harv.).—Ramuli forming broad, dense tufts, mostly at the tips of the branches, crimson. Not uncommon in spring.

15. *P. elongella* Harv.—May be distinguished from *P. elongata* by the visibility of the articulations in all parts of the plant except the extreme base, cortication being much less well developed in the former species. Ramuli not attenuate at the base as in *P. elongata*.

On rocks, stones and the smaller algæ near low-water mark, and at greater depth. Rare; widely distributed.

16. *P. fibrata* Harv.—Plants red when fresh, in tufts 20-23 cm. in length; main branches clothed with numerous ramuli, frequently bearing delicate fibrillæ at their tips; siphons 4 pericentral round a minute central one, a row of corticating cells frequently occurring at the extreme base; articulations variable in length, as much as eight times as long as broad in the main branches; filaments slightly swollen at the junction of the articulations. Tetrasp. intercalary in development, in distorted ramuli; antherid. on apical fibrillæ at the tips of the branches, cystoc. stalked, ovate with large open ostiole.

On rocks, stones and shells at extreme low-water mark. Frequent; widely distributed.

P. fibrata is usually darker in colour than *P. urceolata*, and it may also be distinguished from that species by its gelatinous nature. The arrangement of the siphons is frequently spiral in this species.

17. *P. fibrillosa* Grev.—Plants solitary, brownish or straw-colour in sunny pools, darker in deep water, as much as 15 cms. in length; cartilaginous, gelatinous in smaller branches and ramuli. Siphons 4 primary pericentral, alternating with four secondary; articulations from $1\frac{1}{2}$ to twice as long as broad in the smaller branches and ramuli, obscured in the lower parts. Tetrasp. intercalary; antherid. at the apices of the ramuli; cystoc. ovate, sessile, on the smaller branches.

On rocks, stones and other algæ, such as *Rytiphlaea pinastroides*, in clear sunny tide-pools and in deep water. Rare, but occurring in considerable quantity at uncertain intervals; widely distributed.

18. *P. spinulosa* Grev.—Plants about 5 cm. in height, dark red; branches clothed with short spine-like ramuli; siphons 4 primary, 4-secondary bounded by a band of corticating cells, articulations about equal in length and breadth. Cystoc. ovate, sessile on the smaller branches.

Very rare; Argyle.

var. *major* J. G. Agardh (*P. Carmichaeliana* Harv.).—Lax branching and wide band of corticating cells. Probably in tide-pools. Rare; Argyle, Bute and Orkney.

19. *P. violacea* Harv. (incl. *P. Grevillei* Harv.).—Plants brownish purple, usually 12–15 cm. long, consisting of a main axis, conspicuous at the base, but soon becoming alternately branched, the branches densely clothed with alternate ramuli; siphons 4 primary, alternating with 4 secondary, bounded on the outside by a band of corticating cells. Tetras. in swollen ramuli; cystoc. ovate, usually shortly stalked with no elongation in the region of the ostiole.

On rocks, stones and on other algæ such as *Chorda Filum*, near low-water mark. Rather rare; widely distributed.

var. *Griffithsiana* Batten.—Plant pyramidal in form.

Differing from *P. violacea* Harv. in that the secondary siphons and corticating cells are only present at the extreme base.

var. *subulata* Batten.—Corticate at the base only.

var. *tenuissima* Hauck (*P. divaricata* Kütz.).—Delicate with lax growth, corticate at the base.

B. More than four primary pericentral siphons.

20. *P. Brodiaei* Grev. After J. Brodie, Scottish collector.—Plants dark purplish red, cartilaginous, branched from the base, frequently showing a distinct main axis; branches densely clothed with flaccid, tufted ramuli; siphons 6–8 primary pericentral, alternating with the same number of secondary, bounded by a band of corticating cells; articulations of the main axis and principal branches entirely obscured by the cortication. Tetrasp. intercalary, in swollen ramuli. Cystoc. ovate, shortly stalked.

Occurring near low-water mark and at greater depth on rocks, corallines and shells; flourishing where conditions are turbulent. Common; widely distributed.

var. *densa* Holm. & Batt.—Densely tufted, occurring with the type. Not common.

21. *P. foetidissima* Cocks (*P. stuposa* Ralfs).—Plants gelatinous, in tufts 3–10 cm. in length. Siphons 8–10 pericentral, sometimes bounded by a row of corticating cells at the base. Cystoc. ovate, with a conical elongation towards the ostiole.

On rocks, stones and on other algæ between the tide levels. Very rare; Cornwall, Devon and Sussex.

22. *P. nigrescens* Grev. Lat. *nigrescens*, becoming black.—

Plants rigid, brownish purple, perennial; in tufts as much as 5 cm. diameter, varying from a slender plant about 7 cm. long to a coarse form 30 cm. long, the lower parts clad with the broken remains of old ramuli. Branching variable, but typically

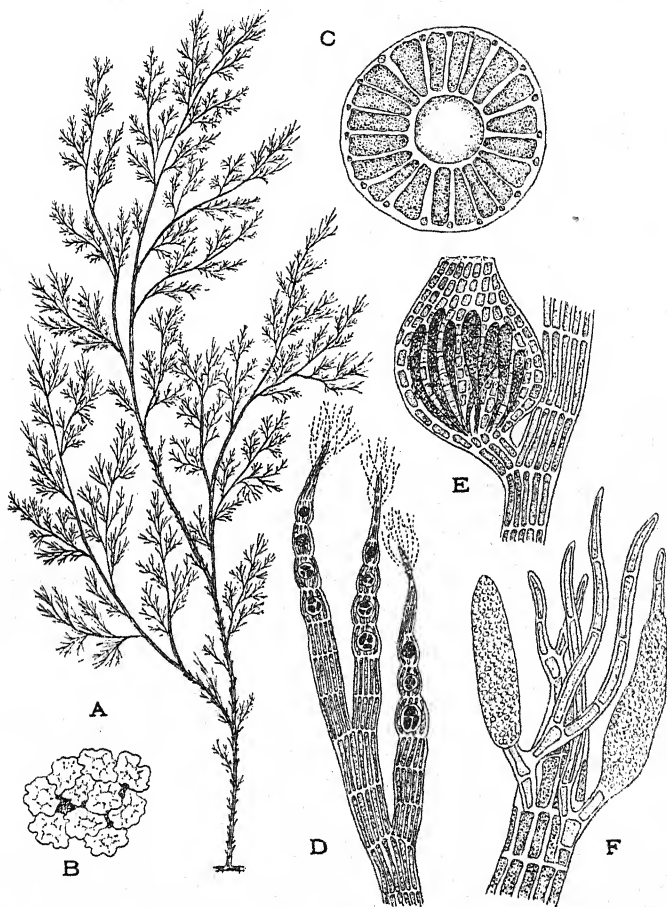


Fig. 212.—*Polysiphonia nigrescens* Grev. A. Plant ($\times \frac{3}{4}$); B. interlocking attachment discs from below ($\times 6$); C. Trans. sect. of main axis near the base ($\times 100$); D. Tips of branches with tetrasp. ($\times 66$); E. cystocarp ($\times 66$); F. Tip of branch with antheridia ($\times 200$).

alternate, the branches subdividing and bearing large numbers of closely pinnate, deciduous, flaccid ramuli, the latter being again doubly pinnate. Siphons 12–20 pericentral round a central

one, with diam. equal to about $\frac{1}{3}$ of the diam. of the filament. A row of small cells frequently bounds the pericentral siphons on the outside at the base. Tetrasp. in the ramuli and uppermost branches, frequently intercalary; antherid. in yellow clusters at the tips of the ramuli, usually among clusters of multicellular hairs; cystoc. broadly egg-shaped and almost sessile.

This species often bears a strong outward resemblance to *Pterosiphonia thuyoides* Sch., although the branching is not so regular. It may be distinguished with a hand-lens by means of the attachment organ, the tiny branches specially modified for attachment which are present in *P. thuyoides* being absent in *P. nigrescens*.

Common almost everywhere on the shores of the British Isles. Shorter than the type; apices of the ramuli truncated.

var. *senticosa* J. G. Agardh.—Shorter than the type; apices of the ramuli truncated. Rather rare; Devon.

var. *protensa* J. G. Agardh (*P. violacea* Harv., non Grev., *P. purpurascens* Harv. Man., *P. atro-purpurea* Moore).—Filaments robust, elongated, rigid below, flaccid above, much branched; lower articulations shorter than broad, upper 2 or 3 times as long as broad; tips of branches truncate or corymbose. Not uncommon; widely distributed.

var. *affinis* J. G. Agardh (*P. affinis*, Moore).—More lax than the type. Rather rare; widely distributed.

23. *P. variegata* J. G. Agardh.—Annual, caespitose, tufts attaining a length of 25 cm., purplish-brown with greenish tint in main branches. Branching pseudodichotomous, widely divergent, main axis flexuose; siphons six pericentral, surrounded by a band of corticating cells in the lower parts. Tetrasp. small, intercalary; antherid. near the tips of the branches. Cystoc. broadly ovate at the base, shortly stalked, on the smaller branches and ramuli.

A mud-loving estuarine species occurring on rocks, stones and on smaller algæ and on the leaves of *Zostera*. Very rare; Southern England.

The nomenclature of this genus is that of the monograph in *Journ. Linn. Soc.*, XLVI, 271 (1923). The strict application of the present International Rules would necessitate a number of changes.

8. PTEROSIPHONIA Falkenb.

(Gr. *pteron*, a wing, and *siphon*, a tube.)

Fronds erect, or rising sharply from the rhizome-like attachment organ, terete or compressed, bearing two rows of alternately pinnate ramuli; structure parenchymatous, axis polysiphonous, 5–12 pericentral siphons, ecorticate or bounded by a band of corticating cells; procumbent attachment organ developed bearing lateral branches, those on the upper side being erect, those on the lower may themselves twist round smaller algæ in addition to bearing numerous rhizoids.

Key.

- | | |
|--------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1. Plants ecorticate | 2. |
| Plants corticate..... | 3. |
| 2. Dark reddish purple. On rocks in sandy bays,
particularly where fresh water runs into the sea | <i>P. pennata</i> (3). |
| Red. Epiphytic on larger algæ, particularly Coral-
lines, at the limit of low tide and in deeper
water | <i>P. parasitica</i> (2). |
| 3. Frond compressed | <i>P. complanata</i> (1). |
| Frond cylindrical | 4. |
| 4. Ramuli regularly pinnate, erect (not spreading) | <i>P. thuyoides</i> (4). |
| Branches and ramuli arising at wide angles,
irregularly pinnate..... | <i>P. fruticulosa</i> (5). |

1. **P. complanata** Schmitz (*Rytiphloea complanata* Harv.). Lat. *complanare*, to make level.—Fronds cartilaginous, compressed, in tufts, 5–10 cm. high; often simple near the base, much branched above; branches bipinnate, bearing two rows of pinnate ramuli; lower portion of the stem naked or clothed with short pinnate ramuli; ramuli subulate, the older ones becoming bifid and gradually multifid; articulations about half as long as broad, marked with longitudinal striæ showing the position of the siphons within the corticating layer.

Very rare; S. England and Ireland.

Distinguishable from *P. thuyoides* and *P. fruticulosa* by its flattened frond.

2. **P. parasitica** Schmitz (*Polysiphonia parasitica* Grev.)—One or more fronds arising from a rhizome-like attachment organ, 2.5–7.5 cm. high; fronds clear red, becoming darker in drying, cylindrical, not compressed; clothed from the base with alternate pinnate branches, which are themselves bipinnately branched, bearing two rows of distichous ramuli; lower branches frequently longer than the upper, giving frond a somewhat triangular shape; branches ecorticate, formed of 8 to 9 pericentral siphons round a smaller central siphon; articulations as long as broad or shorter than their breadth. Tetraspores in swollen ramuli; cystocarps ovate, shortly stalked, on the ramuli.

On *Zostera*, the larger algæ, and particularly on the Coralines at extreme low-water mark; also on perpendicular sides of rocks. Rather rare; widely distributed.

3. **P. pennata** Schmitz (*Polysiphonia pennata* J. G. Agardh).—In tufts 2–5 cm. high; branches bipinnate, bearing rows of bipinnate ramuli. Fronds dark reddish purple, becoming black in drying, ecorticate; articulations about $\frac{1}{3}$ as long as broad, formed of a central siphon and 8 or 9 pericentral; Procumbent parts giving rise alternately to erect and short stunted branches, which bear numerous attachment rhizoids and aid in attachment by twining round another alga. Tetraspores in swollen ramuli; cystocarps ovate, lateral on the ramuli.

On rocks at low water, in sandy bays, particularly where fresh water runs in. Rare; Exmouth.

4. *P. thuyoides* Schmitz (*Rytiphlea thuyoides* Harv.). *Thuya*, genus of Coniferæ; Gk. *eidos*, like.—In tufts 7.5 to 15 cm. high, branched from the base, erect; branches irregular, ramuli regularly pinnate, pinnately branched, corticate; articulations about as long as broad, just visible through the corticating cells, formed of a central siphon, 8–12 pericentral, and several external rows of small cells. Tetrasp. in swollen and distorted ramuli, which are very dense in the tetraspore-bearing region; cystoc. egg-shaped and elongated, tapering near the ostiole, sessile, in large numbers on the ramuli.

In shallow tide-pools on rocky substrata, on Corallines and other small algæ. If the *Fucus serratus* vegetation is not too dense, occurring with *P. fruticulosa* in the lower littoral region. Rather rare; widely distributed.

Attachment organ similar to that of *P. pennata*. In outward form, much resembling *Polysiphonia nigrescens*, from which it is readily distinguished in the field by the form of its attachment organ.

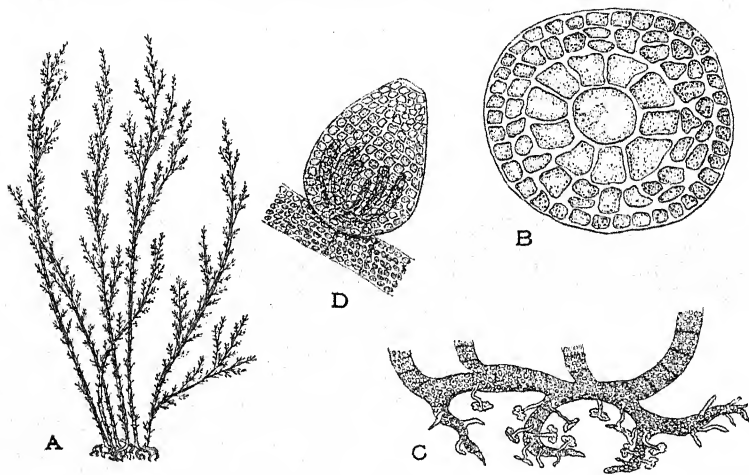


Fig. 213.—*Pterosiphonia thuyoides* Schmitz. A. Plant ($\times \frac{3}{8}$); B. Trans. sect. thallus ($\times 100$); C. Attachment organ ($\times 6$); D. Cystocarp ($\times 66$).

5. *P. fruticulosa* Batten (*Polysiphonia fruticulosa* Spreng., *Rytiphlea fruticulosa* Harv.). Lat. *fruticulus*, small shrub.—Plants dark brownish purple, in tufts from 10–15 cm. high; branching roughly pseudodichotomous in the main branches, with wide angle of divergence, causing characteristically angular appearance; smaller branches irregularly bipinnate, the whole plant being clothed with short spine-like ramuli set at a wide angle; siphons 8–12 pericentral, surrounded by a wide band of

corticating cells. Tetrasp. in swollen and distorted ramuli; cystoc. rare, ovate, sessile, on the ramuli.

In tide-pools on the rocky bottom and particularly in warm shallow pools on coralline algæ. Common; S. England, Ireland and the Channel Islands: rare; Scotland and N. England.

9. BRONGNIARTELLA Bory

(After A. Brongniart, French naturalist.)

Filaments cylindrical, much branched, composed of a central and 5-7 pericentral siphons; clothed throughout with mono-

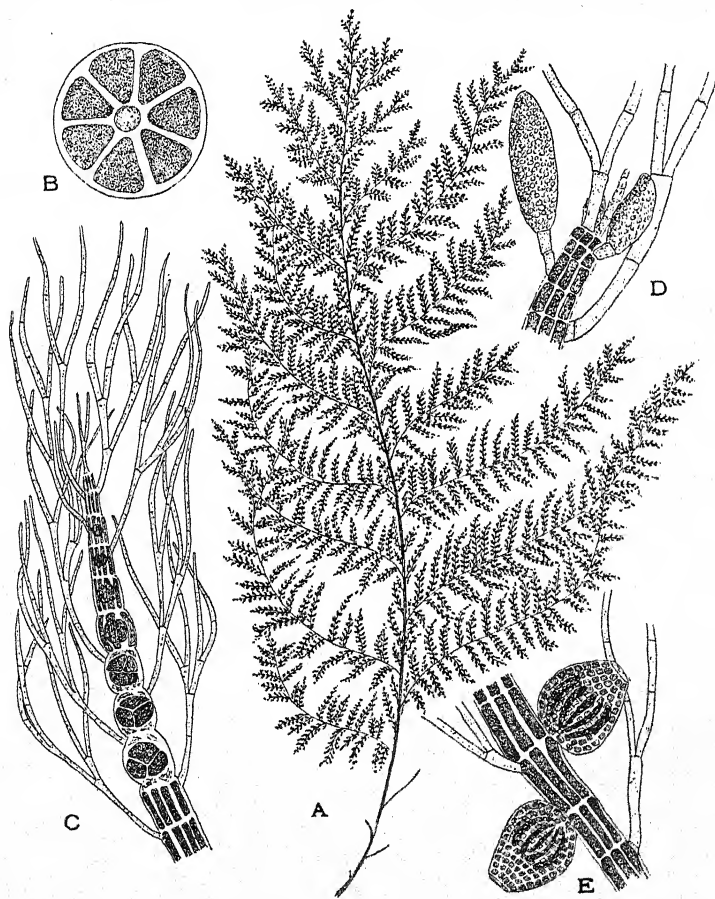


Fig. 214.—*Brongniartella byssoides* Bory. A. Plant ($\times \frac{3}{4}$); B. Trans. sect. thallus ($\times 100$); C. Tetrasporic branch ($\times 66$); D. Tip of branch with antheridia ($\times 66$); E. Cystocarpus ($\times 66$).

siphonous, dichotomous ramuli. Reproduction as in *Polysiphonia*, differing from that genus in the possession of monosiphonous ramuli.

B. byssoides Bory (*Polysiphonia byssoides* Grev.). Gr. *bussos*, fine flax, and *eidos*, like.—Fronds crimson, soft and placid, becoming rigid with age, 15–30 cm. or more long, with a conspicuous main axis, closely set with distichous alternate branches, furnished with a second or third series; branches and branchlets clothed with short, byssoid, monosiphonous ramuli, dichotomously branched; articulations visible throughout, very variable in length. Cystoc. ovate, sessile, scattered on the smaller branches; tetrasp. immersed in the branchlets, one tetrasporang. in each articulation.

On stones, shells, and on other algæ, near low-water mark and at greater depth; often obtained by dredging. Common; S. and E. England and Ireland: rare; Scotland and W. Ireland.

10. *DASYA* C. A. Agardh

(Gr. *dasus*, thick.)

Fronds filiform or compressed, distichous or irregularly branched, composed of one central and 4–12 pericentral siphons, often bounded by a band of corticating cells. Branches clothed with monosiphonous, dichotomous branchlets, which are not hyaline. Cystoc. ovate, acuminate, sessile or pedicellate; antherid. in siliculose tufts on the branchlets; tetrasp. borne in regular rows in lanceolate or ovate lanceolate stichidia.

Key.

- | | |
|-----------------------------------------------------------|----------------------------|
| 1. Ramuli tapering to an acute point | <i>D. corymbifera</i> (1). |
| Ramuli blunt | 2. |
| 2. Ramuli about 7 μ broad | <i>D. punicea</i> (4). |
| Ramuli about 20 μ broad | 3. |
| 3. Stichidia elongated, gradually attenuate upwards | <i>D. ocellata</i> (3). |
| Stichidia elliptic, oblong, mucronate | <i>D. arbuscula</i> (2). |

1. ***D. corymbifera*** Crouan (*D. venusta* Harv.). Lat. *corymbus*, cluster, and *fero*, I bear.—Frond crimson, tender and flaccid, pyramidal, 7.5–10 cm. long; main axis conspicuous, furnished throughout with numerous alternate lateral branches; branches clothed with exceedingly slender, flaccid ramuli, dichotomously branched, attenuate at the apices; articulations 5–6 times as long as broad; axils of the branches acute. Cystoc. on short pedicels, surrounded by a few ramuli, ovate-urceolate with a conical neck; antherid. on the tips of the ramuli, lanceolate; tetrasp. in pedicellate, ovate, acuminate stichidia.

Very rare, usually washed up; Dorset and the Channel Islands.

2. ***D. arbuscula*** C. A. Agardh. Lat. *arbusculus*, small tree.—Fronds crimson or brownish, crisp when fresh, 2.5–10 cm.

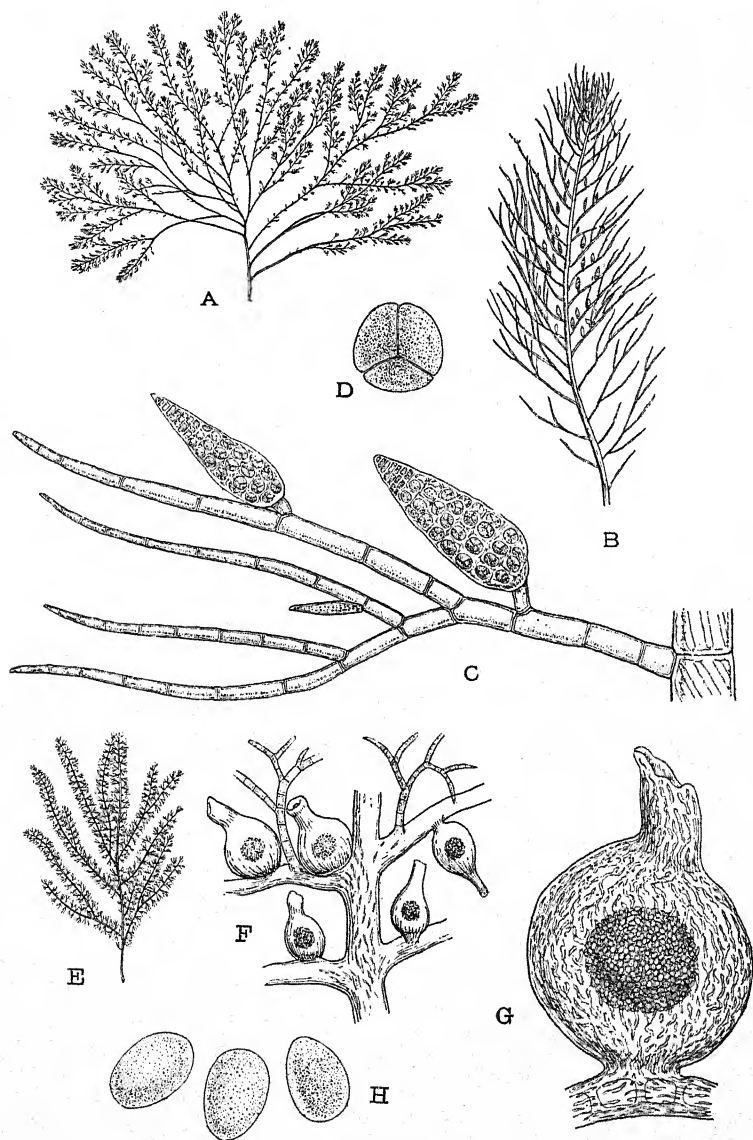


Fig. 215.—*Dasya arbuscula* C. A. Agardh. A. Tetrasporic plant ($\times \frac{1}{3}$); B. frond with tetrasporic stichidia ($\times 6$); C. Portion of the same ($\times 60$); D. Tetrasporangium ($\times 300$); E. Plant with cystocarps ($\times \frac{1}{3}$); F. Portion of same ($\times 8$); G. Cystocarp ($\times 33$); H. Carpospores ($\times 300$).

long, irregularly branched, bushy; branches inarticulate, with 5 pericentral siphons, densely clothed with rigid articulate ramuli, divaricate, several times forked, the axils patent, articulations 2-4 times longer than broad. Cystoc. urceolate with long cylindrical neck, surrounded by a few dichotomous ramuli; tetrasp. in special stichidia, elongated, swollen, pointed at the apex, containing several rows of tetraspores.

On rocks near low-water mark and at greater depth. Rare; widely distributed.

var. *cæspitosa* J. G. Agardh.—Stem purple, shorter and more robust than the type. Padstow.

3. *D. ocellata* Harv. Lat. *ocellus*, little eye.—Fronds brownish or bright purple, membranaceous, 2.5-7.5 cm. high, tufted, simple, once divided or bearing a few simple lateral branches, clothed throughout with long, erect or patent, dichotomous, ramuli, several times divided near their base, cylindrical, apices blunt, articulations 3-4 times longer than broad, monosiphonous. Cystoc. unknown on British specimens; tetrasp. in special lanceolate stichidia, shortly pedicellate, on the ramuli.

On mud-covered rocks in the sea. Very local; widely distributed.

4. *D. punicea* Menegh. (incl. *D. Cattlovæ* Harv.). Lat. *puniceus*, blood-red.—Thallus 5-10 cm. long, terete, composed of one central and 5 pericentral siphons, bounded by a layer of corticating cells, branched on all sides, general form pyramidal; axis and branches clothed with very delicate, monosiphonous dichotomous ramuli, 2-5 mm. long, arising from all sides of the branches, sometimes whorled; articulations of the ramuli twice as long as broad in the lower parts, 3-4 times in the upper. Tetrasp. in ovate or spindle-shaped, stipitate stichidia, on the lower articulations of the ramuli. Very rare; Dorset, Sussex and the Channel Islands.

11. *HETEROSIPHONIA* Mont.

(Gr. *heteros*, different, and *siphon*, a tube.)

Thallus usually erect, with dorsiventral symmetry; ramuli in two rows, one on each side of the branches. Consisting of one central and a row of pericentral siphons, bounded at the base by a band of longitudinally elongated cortical cells. Articulations only visible in the smaller branches and ramuli, about as long as broad. Cyst. urceolate, ovoid; tetrasp. borne in elongated, cylindrical, pedicellate stichidia.

H. plumosa Batt. (*Dasya coccinea* C. A. Agardh). Lat. *plumosus*, feathered.—Thallus deep crimson, 15-20 cm. or more long, with conspicuous central axis, gradually attenuate upwards, distichously branched, clothed with shaggy hairs; branches

bi-tri-pinnate, spreading; ultimate pinnules forked or multifid, with numerous monosiphonous ramuli; articulations visible in the smaller branches and ramuli, about as long as broad; main axis consisting of one central and nine pericentral siphons, in addition to a layer of corticating cells and hair-like proliferations. Cystoc. ovate, on the branchlets among the ramuli; tetrasp. in oblong, mucronate stichidia, very shortly stipitate.

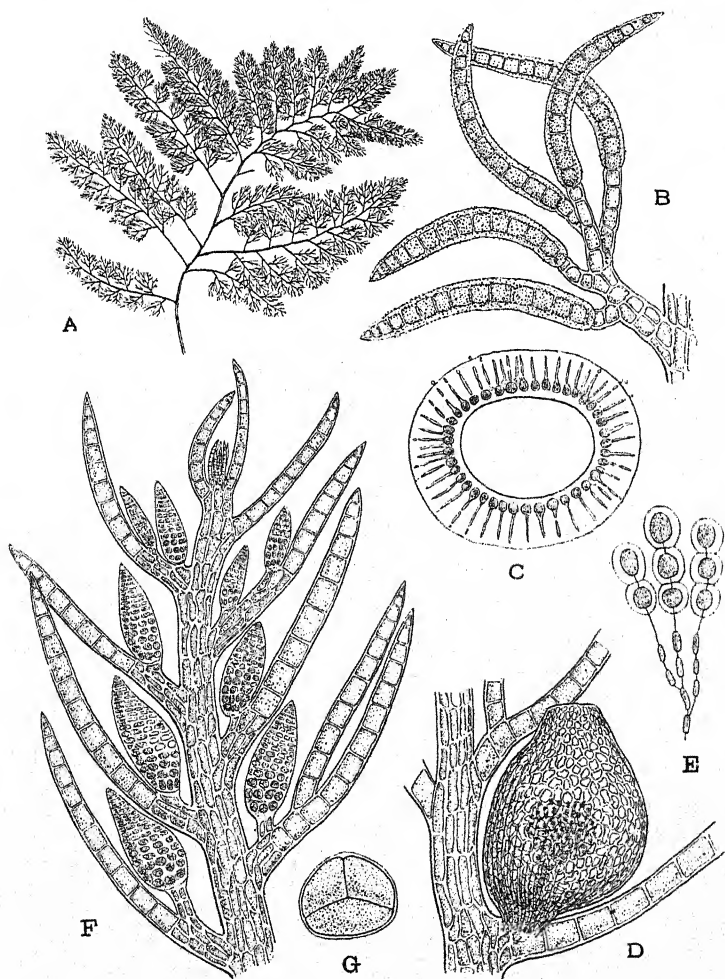


Fig. 216.—*Heterosiphonia plumosa* Batt. A. Plant ($\times \frac{1}{2}$); B. Antheridial ramuli ($\times 33$); C. Trans. sect. of same ($\times 300$); D. Cystocarp ($\times 33$); E. Carpospores borne in chains ($\times 300$); F. Portion of tetrasporic plant ($\times 33$); G. Tetrasporang. ($\times 300$).

On rocks and algæ near low-water mark. Common; England, Ireland and the Channel Islands; rare in Scotland.

var. *tenuior* Batt. (*Dasya coccinea* var. *tenuis* J. G. Agardh, *D. media* Harv.).—More slender than the type. Rare; dredged in 4–10 fathoms.

var. *patens* Batt. (*Dasya patens* Grev., *D. coccinea* var. *squarrosa* Harv.).—Branches destitute of hair-like fibres, sparingly and often irregularly branched; ramuli squarrose. Rare; widely distributed.

Family VII.—CERAMIACEÆ

Thallus formed of monosiphonous filaments, naked or corticated by secondary filaments developed at the nodes and adhering to the main axis. Procarp. exterior to the thallus; cystoc. often formed of two gonimoblasts; tetrasporang. usually tetrahedral and exterior.

1. SPHONDYLOTHAMNION Naeg.

(Gr. *sphondulos*, a whorl, and *thamnion*, a small bush.)

Thallus monosiphonous, ecorticate, consisting of a main filamentous axis, bearing at each articulation a whorl of branchlets and ramuli. Cyst. terminal on the ramuli, spherical, enclosed in a whorl of branches. Tetrasp. spherical, sessile, borne near the base of the ramuli.

S. multifidum Naeg. (*Wrangelia multifida* J. G. Agardh). Lat. *multifidus*, many cleft.—Plants rose-red and crisp when fresh, soon becoming flaccid, 10–20 cm. long; main axis usually undivided, furnished throughout with lateral, opposite or alternate, spreading, pinnate or bipinnate branches; axis and branches monosiphonous, bearing, at each articulation, a pair or a whorl of sub-dichotomous, much-branched ramuli; articulations 5–10 times longer than broad in the branches, 2–3 times in the ramuli. Cystoc. terminal on the ramuli, enclosed in a whorl of branchlets; tetrasp. sessile on the lower part of the ramuli.

On the perpendicular sides of deep pools near low-water mark, often in the shade. Common; S. England and W. Ireland.

var. *pilifera* Batt.—Ramuli very long, simple, hair-like. Rare; Cornwall, Devon and Sussex.

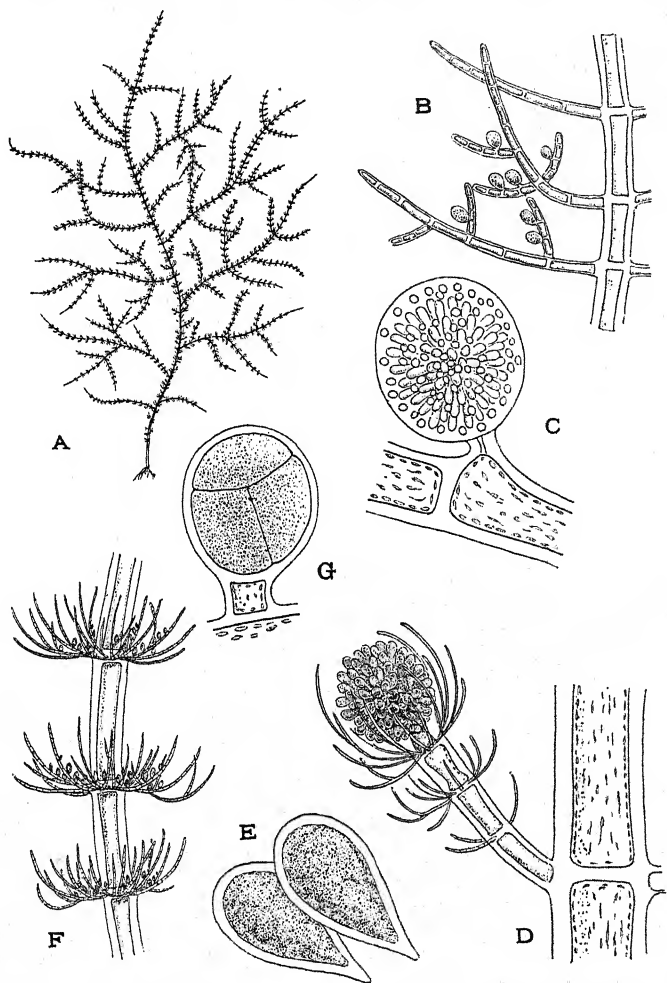


Fig. 217.—*Sphondylothamnion multifidum* Naeg. A. Plant ($\times 3$); B. Antheridial ramuli ($\times 33$); C. The same ($\times 300$); D. Ramulus with cystocarp ($\times 33$); E. Carpospores ($\times 300$); F. Ramuli bearing tetraspores ($\times 33$); G. Single tetrasporang. ($\times 300$).

2. SPERMOTHAMNION Aresch.

(Gr. *sperma*, a seed, and *thamnion*, a small bush.)

Fronds tufted, composed of procumbent filaments attached to the substratum by rhizoids and erect fronds; thallus monosiphonous, ecorticate, much branched. Cystoc. terminal on the

branches, surrounded by a group of short incurved branchlets ; spores free, not surrounded by a gelatinous envelope ; antherid. sessile on the inner side of the branches ; tetrasporang. single or in groups, borne on the inner side of the branchlets.

Differing from *Callithamnion* in the absence of a gelatinous envelope enclosing the carpospores.

- | | |
|---------------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1. Lower branches arising on all sides of the main axes, upper branches pinnate, ramuli secund | <i>S. strictum</i> (2). |
| Ramuli opposite, at least in the lower parts ... | 2. |
| 2. Lower ramuli opposite, upper ramuli secund, articulations contracted, colour purple | <i>S. irregulare</i> (4). |
| Ramuli nowhere secund | 3. |
| 3. Ramuli opposite, erect, short and spine-like, clothing the tips of the branches ; occurring on mud-covered rocks | <i>S. barbatum</i> (3). |
| Ramuli opposite, spreading, elongate, sometimes branched ; epiphytic on other algæ | <i>S. Turneri</i> (1). |

1. **S. Turneri** Aresch (*Callithamnion Turneri* C. A. Agardh). After Dawson Turner, British algologist.—Filaments densely tufted, 2.5–5 cm. high, rising from procumbent branches. Erect filaments simple or repeatedly branched, once or twice pinnated with opposite, spreading, simple, or rarely alternately branched ramuli ; articulations of the main axes 5–10 times longer than broad, those of the ramuli 4–5 times as long as broad. Cystoc. lateral or terminal on shortened ramuli ; tetrasp. tetrahedral, sessile on the sides of short, simple or branched proliferations, formed near the base of the ramuli.

Epiphytic on other algæ, between the tide-marks. Common ; widely distributed

var. **monoica** Schmitz (*Callithamnion Turneri* var. *variabile* J. G. Agardh, var. *repens* auct., *S. roseolum* Pringsh., *S. hermaproditum* auct.).—Branches and branchlets alternate or secund. Not uncommon ; N. England and Scotland.

var. **sphaericum** Batt. (*Callithamnion sphaericum* J. G. Agardh, *Rhodochorton intermedium* Batt., non Kjellm.).—Globose-cæspitose, filaments radiating from the base, branches fastigate, ramuli few below, dense and erect in the upper parts ; articulations contracted at the nodes, twice as long as broad ; tetraspores present. Rare ; Northumberland.

2. **S. strictum** Ardiss. (*S. flabellatum* Holm. & Batt.). Lat. *strictus*, drawn together.—Plants rose-red, rigid, in tufts 1–2 cm. long, much branched ; lower branches arising irregularly on all sides of the main axes, upper branches pinnate ; ramuli secund, erect, adpressed ; articulations 3–4 times longer than broad. Tetrasporang. on the inner side of lateral branchlets, in a second series.

Very rare ; Sussex, Edinburgh and Argyle.

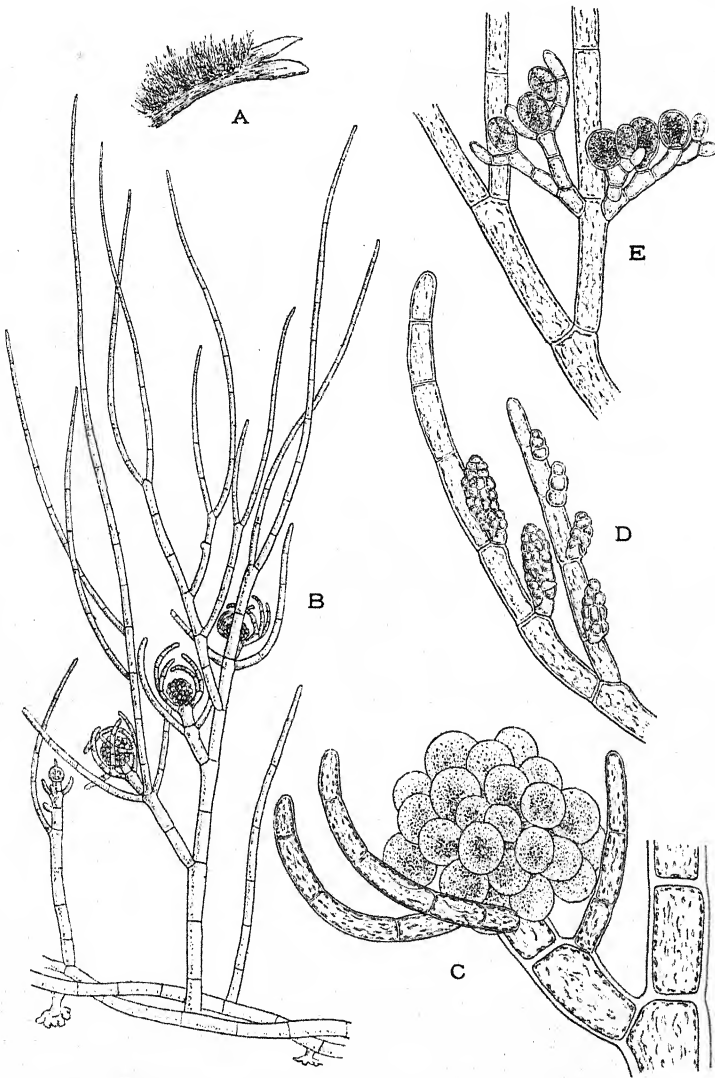


Fig. 218.—*Spermothamnion strictum* Ardiss. A. Plants ($\times \frac{3}{2}$); B. Portion of plant showing procumbent filaments and cystocarps ($\times 12$); C. Cystocarp ($\times 160$); D. Antheridia ($\times 160$); E. Tetrasporic ramuli ($\times 160$).

3. *S. barbatus* Born. (*Antithamnion barbatus* Holm. & Batt.). Lat. *barbatus*, bearded.—Plants dull brownish red, membranaceous, somewhat rigid in close tufts, 2.5-5 cm. high,

much and irregularly branched; branches alternate or opposite, erect, long, simple or bearing branchlets, their upper half closely pinnulated with very short, opposite, spine-like ramuli, the lower half sometimes naked; articulations 2-3 times as long as broad. Tetrasporang. elliptic, sessile, usually solitary on the sides of the ramuli.

On mud-covered rocks between tide-marks. Very rare; widely distributed.

var. *mesocarpum* Batt. (*Callithamnion mesocarpum* Carm.).—Cæspitose tufts, shorter than the type. Very rare; widely distributed.

4. *S. irregulare* Ardiss.—Plants purple, membranaceous, somewhat rigid. In tufts 1-3 cm. long, erect filaments branched; articulations somewhat contracted, 2-4 times as long as broad; branches patent; lower ramuli opposite, multifid; upper ramuli secund. Cystoc. terminal, enclosed within a group of ramuli; tetrasporang. sessile or shortly pedicellate.

Very rare; Weymouth.

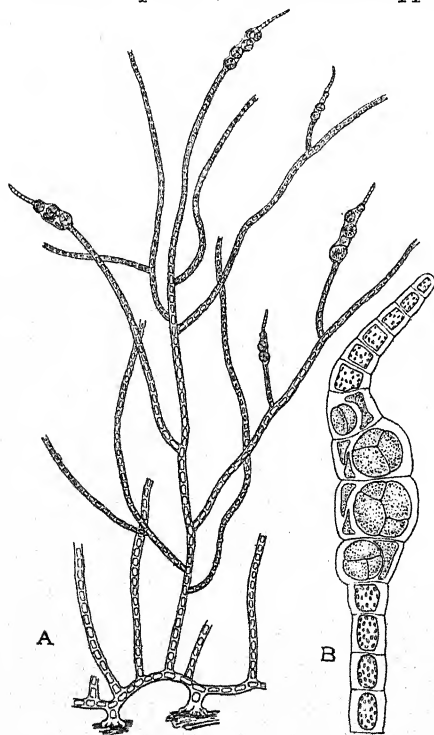


Fig. 219.—*Trailliella intricata* Batt. A. Plant with tetraspores ($\times 33$); B. Tetrasporic filament ($\times 130$).

3. *TRAILLIELLA* Batt.

(After G. W. Traill, Scottish algologist.)

Fronds composed of monosiphonous, branching, jointed filaments; primary filaments procumbent, attached to the substratum by disc-shaped cells; secondary filaments erect, branches arising from the primary. Tetrasp. immersed in the frond, irregularly cruciate; cystoc. and antherid. unknown.

T. intricata Batt. Lat. *intricatus*, tangled.—Fronds rose or brownish red, forming dense tufts; primary filaments 30-40 μ thick, irregularly branched; secondary filaments erect, 1.75-4.25 cm. long, 30-45 μ broad, simple or branched, more or less naked below, pinnate above, with alternate or subsecund

branches, tapering at the apices to about 20μ ; cells of primary and secondary filaments $1\frac{1}{2}$ – $2\frac{1}{2}$ times longer than broad, more or less swollen in the middle. Tetrasp. in the swollen cells of the secondary filaments, 50 – 60μ diam., solitary or 3–6 together, formed from successive cells of the filament, intercalary. S. England.

4. **PTILOTHAMNION** Thur.

(Gr. *ptilon*, a feather, and *thamnion*, a small bush.)

Fronds minute, filiform, articulate, monosiphonous, consisting of a creeping portion attached to the substratum by rhizoids, and erect branches, irregularly branched, bearing

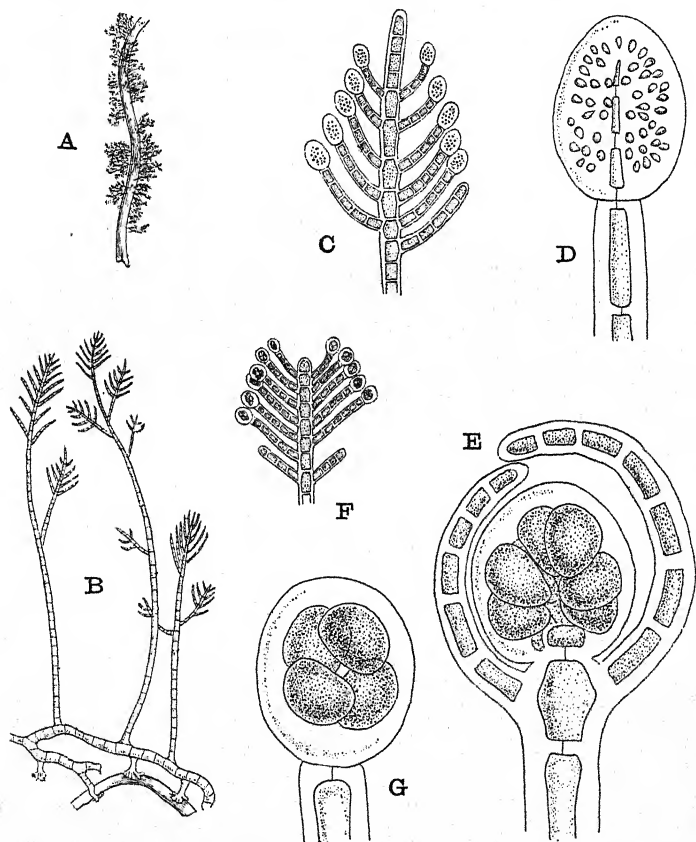


Fig. 220.—*Ptilothamnion pluma* Thur. A. Plant ($\times 1$); B. Portion of same with attachment rhizoids ($\times 12$); C. Ramuli with antheridia ($\times 60$); D. Portion of the same ($\times 300$); E. Cystocarp ($\times 300$); F. Tetrasporic ramuli ($\times 60$); G. Single ripe tetrasporang. ($\times 300$).

pinnate ramuli. Cystoc. enclosed in gelatinous pericarp, terminally on the ramuli; carposp. formed in basipetal succession; antherid. oval or elongate, on the ramuli; tetrasp. tetrahedral, terminal or lateral on the ramuli.

P. pluma Thur. (*Callithamnion pluma* C. A. Agardh). Lat. *pluma*, soft feather.—Erect fronds, clear crimson, membranaceous, arising from creeping filaments, 1.75 cm. high or slightly more, very slender, simple or furnished with alternate or opposite, very erect branches, the latter naked below, clothed in their upper parts with closely pinnate, opposite, erect, simple ramuli, one pair arising from each articulation; ramuli sometimes suppressed on one side, giving secund appearance; articulations 3–4 times as long as broad in the main axes, shorter in the branches, equal in length and breadth in the ramuli. Tetrasporang. globose, either terminating shortened ramuli, or lateral on the ramuli.

Forming velvety patches on the stipes of *Laminaria digitata*. Rather rare; widely distributed.

5. GRIFFITHSIA C. A. Agardh

(After Mrs. Griffiths, British algologist.)

Fronds filiform, monosiphonous, ecarticate, mostly dichotomously branched; cells large, cylindrical globose or clavate. Cystoc. attached to whorled involucrel ramuli, gelatinous envelope present; antherid. sessile on the upper half of the globose terminal cells, surrounding the nodes in tufts or in dense whorls attached to the inner side of incurved branchlets; tetrasp. tetrahedral, tetrasporang. clustered in whorls at the nodes or on the inner side of short branches. Cystoc. antherid. and tetrasp. on separate plants.

Key.

- | | |
|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 1. Cells in the middle parts of the plant, pyriform
Cells cylindrical, sometimes contracted at the
nodes | 2. |
| 2. Upper branches clothed at each node with whorls
of long byssoïd dichotomous ramuli, bearing
tetraspores | 3. |
| Ultimate ramuli moniliform; tetrasp. sessile at
the nodes, surrounded by short ramuli | <i>G. barbata</i> (4). |
| 3. Rigid, lesser branches attenuate to a fine point;
tetrasp. in whorls at the apices of short
branchlets | <i>G. corallinoides</i> (1). |
| Gelatinous, flaccid, apices of the ramuli blunt;
tetrasp. in whorls at the upper end of the arti-
culations of the filaments | <i>G. flosculosa</i> (2). |
| | <i>G. devoniensis</i> (3). |

1. **G. corallinoides** Batt. (*Griffithsia corallina* C. A. Agardh). *Corallina*, a genus of algæ, and *Gr. eidos*, like.—Fronds crimson, gelatinous, tufted, 5–20 cm. long, repeatedly and regularly

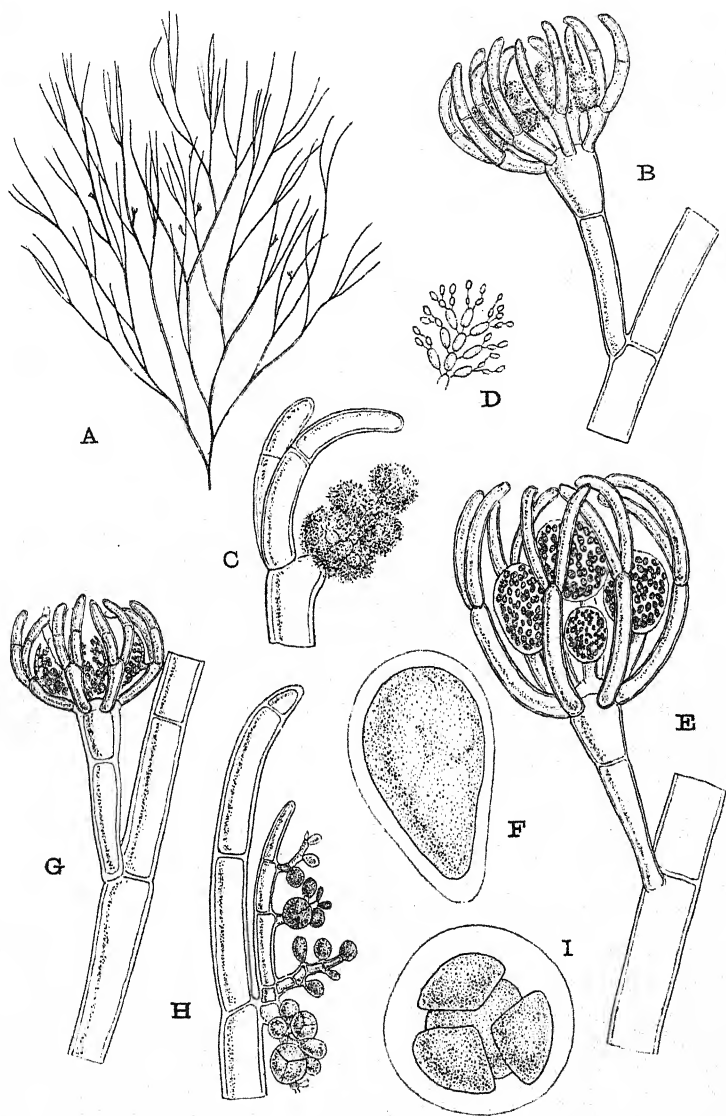


Fig. 221.—*Griffithsia fosculosa* Batt. A. plant ($\times 3$); B. Antheridial ramuli ($\times 33$); C. Portion of the same ($\times 90$); D. The same ($\times 300$); E. Cystocarpic branch ($\times 33$); F. Carpospore ($\times 300$); G. Tetrasporic ramuli ($\times 33$); H. Portion of the same ($\times 90$); I. Single tetrasporang. ($\times 300$).

dichotomous, fastigate; lesser branches more irregular, often alternate, more slender than the remainder of the frond; axils wide in the lower parts, narrow in the upper; articulations 2-4 times longer than broad, cylindrical near the base, pyriform in the middle parts, moniliform above. Cystoc. 2 or 3 together, sessile at the apex of an articulation, lateral, occupying the place of a suppressed branch, surrounded by short ramuli; tetrasporang. densely clustered in whorls round the nodes, surrounded by short ramuli. Smell strong and unpleasant.

Not uncommon; widely distributed.

2. *G. flosculosa* Batt. (*Griffithsia setacea* C. A. Agardh). Lat. *flosculus*, little flower.—Fronds tufted, 7.5-20 cm. or more long, frequently interwoven below; filaments gradually attenuate upwards, many times dichotomous at short intervals; axils very acute; lesser branches alternate or secund, frequently opposite, attenuate upwards. Articulations cylindrical, 5-6 times as long as broad or longer in the lower parts, gradually shorter upwards. Cystoc. oval, terminal on short lateral branchlets, surrounded by short ramuli; anth. and tetrasp. on separate plants, terminal on lateral branchlets, surrounded by an involucre of ramuli. Colour clear crimson, instantly discharged in fresh water. Substance rigid and crisp when fresh.

On the perpendicular sides of deep rock pools, near low-water mark, in the shade. Common; widely distributed.

3. *G. devoniensis* Harv.—Filaments rose-red, gelatinous, flaccid, tufted, 5-7.5 cm. long, very slender, dichotomously branched, fastigate, the lower axils patent, the upper acute; articulations cylindrical, 7-8 times as long as broad, slightly broadened at each end, constricted at the nodes. Tetrasporang. on the inner face of short ramuli, densely whorled round the main filaments at the upper extremity of an articulation.

Muddy shores in deep water. Very rare; Cornwall, Devon and Channel Islands.

4. *G. barbata* C. A. Agardh. Lat. *barbatus*, bearded.—Filaments rose-red, tender and lubricous, 2.5-7.5 cm. long, capillary and byssoïd above, forming dense fastigate tufts, repeatedly dichotomous; lower axils distant and patent, the upper close together and acute; branches naked below, clothed above with opposite or whorled, very slender, byssoïd, dichotomous, spreading ramuli; articulations 5-8 times as long as broad, cylindrical, or slightly swollen above. Cystoc. at the apices of truncated branches, usually in pairs, surrounded by numerous forked ramuli; tetrasporang. spherical, sessile on the byssoïd ramuli.

Epiphytic on the smaller algæ, in tide pools. Very rare; S. England and Channel Islands.

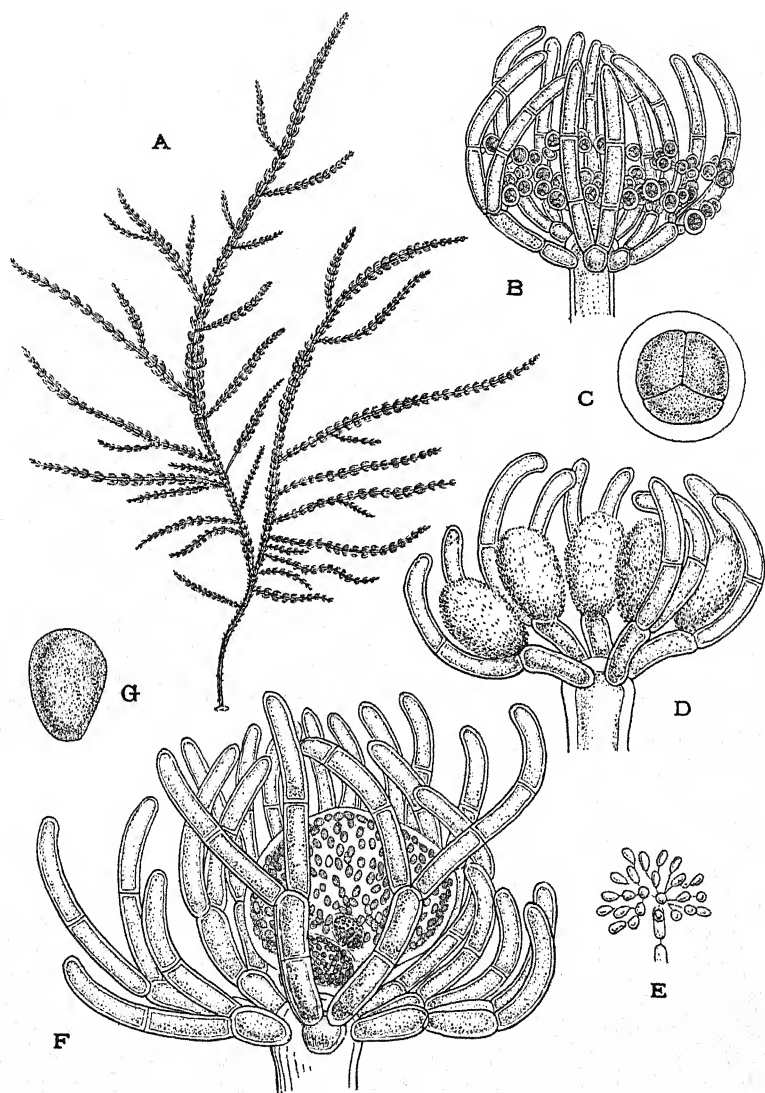


Fig. 222.—*Halurus equisetifolius* Kütz. A. Plant ($\times 3$); B. Tetrasporic ramuli ($\times 33$); C. Single tetrasporang. ($\times 200$); D. Antheridial ramuli ($\times 33$); E. Portion of the same ($\times 300$); F. Cystocarp ($\times 33$); G. Carpospore ($\times 300$).

6. HALURUS Kütz.

(Gr. *hals*, the sea, and *oura*, a tail.)

Fronds monosiphonous, branching, beset throughout with short incurved, di-trichotomous, whorled ramuli. Tetrasp. tetrahedral, attached to the inner side of special dichotomous ramuli, borne in an involucre, laterally placed on the branches. Anth. similarly placed to the tetrasp. Cystoc. terminal on short branches.

H. equisetifolius Kütz. (*Griffithsia equisetifolia* C. A. Agardh). Lat. *Equisetum*, the horsetail plant, and *folium*, a leaf.—Plants dark full red, firm, somewhat cartilaginous, mostly solitary, 7.5–22.5 cm. long, much and irregularly branched, clothed throughout with short ramuli, regularly whorled on the young parts, densely aggregated in the older; main branches long, bearing a second or third series of irregular branchlets and ramuli; ramuli incurved, articulations 3–4 times as long as broad in the ramuli, twice as long as broad in the branches. Cystoc. imperfectly surrounded by short ramuli at the apices of short branches; antherid. and tetrasporang. within a whorl of short ramuli, lateral on the branches.

On rocks at extreme low-water mark. Not uncommon; widely distributed.

var. **simplicifilum** J. G. Agardh. (*Griffithsia simplicifilum* C. A. Agardh).—Articulations of the ramuli, 8–12 times as long as broad; ramuli straight, erect. Very rare; widely distributed.

7. BORNETIA Thur.

(After E. Bornet, French algologist.)

Differing from *Griffithsia* in the absence of a gelatinous envelope surrounding the cystocarps.

B. secundiflora Thur. (*Griffithsia secundiflora* J. G. Agardh). Lat. *secundus*, directed to one side, and *flos*, flower.—Fronds crimson, gelatinous, membranaceous, firm, tufted, somewhat fan-shaped, 10–20 cm. long, usually simple at the base, afterwards repeatedly and dichotomously branched; the lesser branches often alternate or secund; apices blunt, not attenuate; articulations cylindrical or slightly pyriform, 2–4 times as long as broad. Cystoc. terminal on short branches, surrounded by a whorl of ramuli; tetrasporang. and antherid. on separate plants on the inner side of whorled ramuli.

On rocks at extreme low-water mark. Very rare; England: not uncommon; Channel Islands.

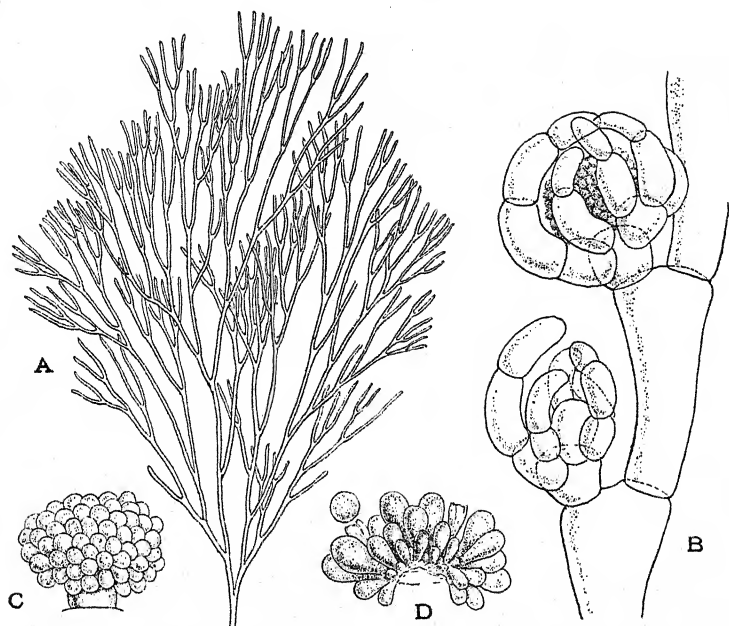


Fig. 223.—*Bornetia secundiflora* Thur. A. Plant ($\times \frac{1}{2}$); B. Portion of frond with cystocarps ($\times 16$); C. Cystocarp (without enveloping ramuli) ($\times 33$); D. Portion of the same ($\times 60$). (B, C and D after Thuret.)

8. MONOSPORA Solier

(Gr. *monos*, single, and *spora*, a seed.)

Filaments much branched, monosiphonous, ecorticate. Cystoc. on short terminal branchlets, surrounded by a whorl of short ramuli; antherid. ovoid, lateral on the branches; tetrasporang. tetrahedral, axillary, shortly pedicellate, replaced in some species by large ovoid or claviform undivided cells, similarly placed and containing one large spore.

M. pedicellata Solier (*Callithamnion pedicellatum* C. A. Agardh and *Monospora clavata* J. G. Agardh). Lat. *pediculus*, a small foot. —Fronds pinkish red, crisp, soon becoming flaccid, densely tufted, 5–20 cm. long, irregularly divided; branches sometimes nearly simple, long and virgate, sometimes repeatedly branched, somewhat flabellate, more or less fastigiate, seldom naked, usually bearing once or twice dichotomous alternate ramuli at each articulation; ultimate divisions of the ramuli often incurved, cylindrical, very obtuse; articulations variable, 3–12 times as long as broad. Cystoc. unknown on British specimens; monosp. undivided, elliptical or pyriform, axillary, shortly stipitate.

On rocks and woodwork near low-water mark, mostly in deep pools or in deeper water. Not uncommon; S. England and Scotland: common; Ireland and Channel Islands.

var. *comosa* Holm. & Batt. Rare; S. England and Alderney.

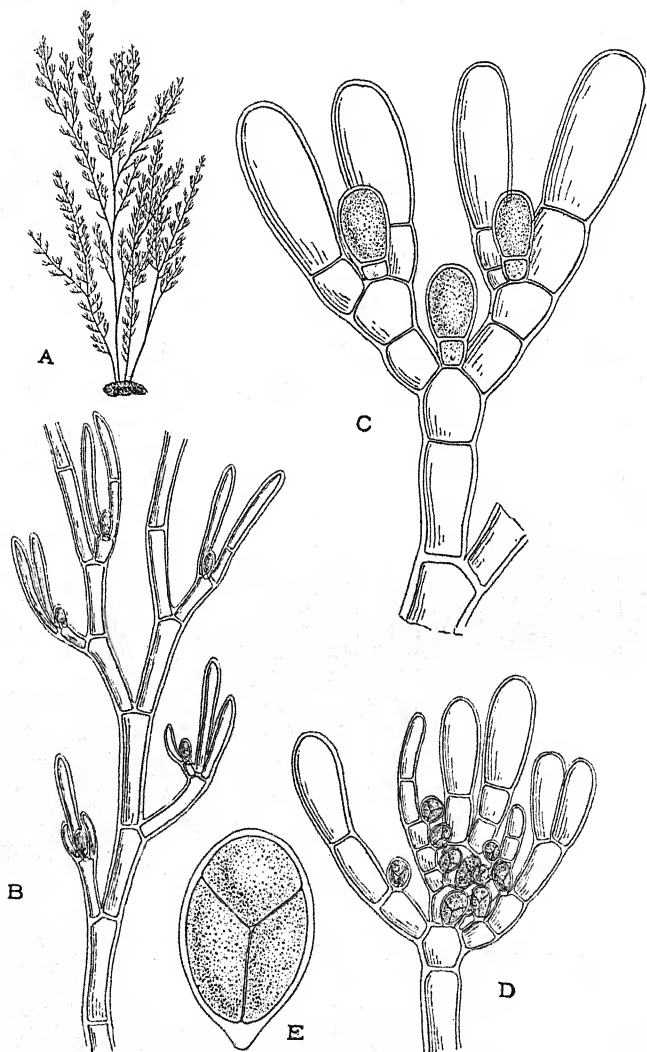


Fig. 224.—*Monospora pedicellata* Sol. A. Plant ($\times \frac{3}{8}$); B. Portion of the same ($\times 12$); C. Portion showing monospores ($\times 60$); D. Portion with tetraspores ($\times 60$); E. single tetrasporang. ($\times 300$).

9. PLEONOSPORIUM Naeg.

(From *pleon*, many, and *spora*, a seed.)

Filaments monosiphonous, ecorticate, pinnately branched, set with distichous ramuli. Antherid. and tetrasporang. on separate plants, on the inner sides of the ramuli, one tetra-

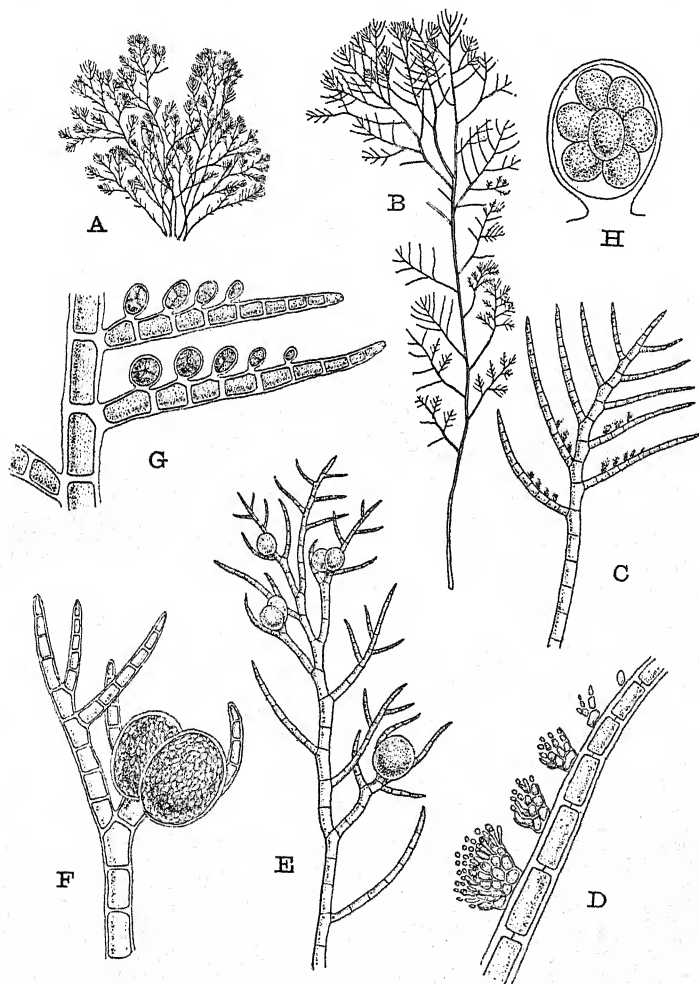


Fig. 225.—*Pleonosporium Borreri* Naeg. A. Plant ($\times 1$); B. Portion ($\times 2$); C. Antheridial ramuli ($\times 60$); D. Portion of the same ($\times 300$); E. Portion of cystocarpic plant ($\times 16$); F. Portion of the same ($\times 33$); G. Tetrasporic ramuli ($\times 60$); H. Sporangium with more than 4 spores ($\times 300$).

sporang. or a group of antherid. on each articulation; cystoc. lateral, near the apices of the smaller branches, usually in pairs.

P. Borreri Naeg. (*Callithamnion Borreri* Harv.). After W. Borrer, English botanist.—Plants deep red, brownish towards the base; rather rigid when fresh, soon becoming flaccid, densely tufted, 2.5–12.5 cm. long; larger specimens excessively branched in an alternately pinnate series. Branches more or less distichous, long, bearing 3 or 4 series of smaller branches; the apices clothed with distichous pinnate ramuli, alternate, patent, very slender, issuing from each articulation. Articulations 100–160 μ broad, 3–5 times as long as broad in main axes, twice as long as broad in the ramuli. Cystoc. usually in pairs; antherid. and tetrasporang. sessile on the inner surfaces of the ramuli, borne on each articulation; 4 or more spores in each sporang.

On mud-covered rocks, near low-water mark. Rare; widely distributed.

var. **fasciculatum** Holm. & Batt. (*Callithamnion fasciculatum* Harv.).—Articulations constricted at the node, broader than the type. Very rare; Devon and Norfolk.

10. RHODOCHORTON Naeg.

(Gr. *rhodon*, rose, and *chortos*, grass.)

Consisting of monosiphonous, ecorticate filaments; attachment organ either discoid or consisting of procumbent filaments, from which the erect filaments arise. Tetrasp. cruciate, on the erect filaments; other organs of reproduction unknown.

Key.

- | | |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Procumbent filaments united into a basal disc | 2. |
| Procumbent filaments not united | 5. |
| 2. Tetrasporang. axillary | 3. |
| Tetrasporang. terminal or lateral | 4. |
| 3. Erect filaments 0.5–1 mm. high, articulations 2–6 times as long as broad. On <i>Polysiphonia</i> , <i>Cystoclonium</i> and other algæ | <i>R. minutum</i> (3). |
| Erect filaments about 5 mm. high, articulations 5–6 times as long as broad, forming red tufts on the larger algæ | <i>R. pallens</i> (5). |
| 4. Articulations 1–8 times as long as broad, tetrasporang. terminal, epiphytic on Bryozoa, Hydrozoa and sometimes on other algæ | <i>R. membranaceum</i> (2). |
| Articulations 1–1½ times as long as broad, tetrasporang. terminal or secund; on <i>Polysiphonia</i> and other algæ | <i>R. sciriolanum</i> (4). |
| 5. Apices attenuate into long hairs, endophytic in the outer layers of <i>Glossosiphonia capillaris</i> | <i>R. Brebneri</i> (1). |
| Apices not attenuate | 6. |
| 6. Tetrasporang. in clusters on short corymbose ramuli | <i>R. Rothii</i> (6). |
| Tetrasporang. secund | <i>R. floridulum</i> (7). |

1. **R. Brebneri** Batt. After G. Brebner, Scottish botanist.—Primary filaments decumbent, sparsely branched, 9μ broad, creeping in the thallus of the host; fertile branches erect, attenuate at the apices into elongated hairs, much and irregularly branched, tufted. Tetrasp. cruciate, terminal or lateral, solitary or gregarious, ovate or oblong, 18–30 by $20\text{--}30\mu$.

In the fronds of *Gloiosiphonia capillaris*. Very rare; Plymouth.

2. **R. membranaceum** Magn. (incl. var. *macroclada* Rosenv.).—Procumbent filaments creeping on the surface or in the outer membrane of the host, much branched, forming a pseudoparenchymatous disc; cells 10μ by $4\text{--}42\mu$; erect filaments short, simple or slightly branched. Tetrasp. terminal, new tetrasporang. being formed within the sheaths of the old ones.

On Bryozoa, Hydrozoa and sometimes on other algæ. Often forming a membranous lining in the tubes of Sertulariæ, the fertile branches projecting through the orifices of the polyp cells.

3. **R. minutum** Reinke.—Thallus epiphytic, erect branches 0.5–1 mm. high; branches unilateral, apices bearing hyaline hairs; articulations 2–6 times as long as broad; attachment organ a pseudoparenchymatous disc, creeping on the surface of the host. Tetrasporang. single or in pairs, on short pedicels or sessile, axillary.

On *Polysiphonia*, *Cystoclonium* and other algæ. Very rare; Dorset.

4. **R. seiriolanum** Harv. Gibs. After St. Seiriol's Isle (Puffin Island).—Plants rose-red, attached by a discoid basal layer, creeping on the thallus of the host; erect filaments minute, simple; articulations 1 or $1\frac{1}{2}$ times as long as broad. Tetrasporang. terminal, second or lateral, a new sporang. often being formed in the sheath of the old one.

On *Polysiphonia urceolata* and other algæ at low-water mark. Very rare; Anglesea.

5. **R. pallens** Hauck. Lat. *pallens*, wan.—Plants red, tufted, epiphytic, about 5 mm. high; attached by a pseudoparenchymatous disc, $10\text{--}12\mu$ thick; erect filaments simple or branched, apices bearing hyaline hairs, articulations 5–6 times longer than their breadth. Tetrasporang. on the inner side of the branches, single or 2 or 3 together on a short stalk, rarely sessile, axillary.

On the larger algæ. Very rare; Devon.

6. **R. Rothii** Naeg. (*Callithamnion Rothii* Lyngb. and *R. parasiticum* Batt.). After A. W. Roth, German botanist.—Filaments as much 1.75 cm. long. Attached by procumbent filaments creeping on the substratum, erect filaments $10\text{--}18\mu$ broad, articulations 1–5 times longer than broad, sparingly branched, very erect; apices bearing dichotomous or corymbose ramuli on which the tetrasp. are borne in terminal clusters.

Spreading over the surface of the rocks in velvety patches at about half-tide level, or creeping on other algæ. Occurring also in a sandy substratum, associated with *Polysiphonia pulvinata*. Common; widely distributed.

R. parasiticum Batt., creeping among the dead outer tissues of *Laminaria*, is now known to belong to the present species.

7. *R. floridulum* Naeg. (*Callithamnion floridulum* C. A. Agardh).—Forming dense, globose, fastigate tufts. Procumbent filaments creeping in the sand; erect filaments slender, dichotomous or alternately branched; branches few, erect or adpressed; articulations about 3 times as long as broad. Tetrasp. oval, second, on short pedicels on the upper branches.

On sand-covered rocks. Not uncommon; widely distributed.

11. *CALLITHAMNION* Lyngb.

(Gr. *kallos*, beauty, and *thamnion*, a small bush.)

Fronds filamentous, branching, monosiphonous, sometimes corticate at the base, cortication formed by rhizoidal filaments. Cystoc. usually in pairs; carposp. roundish, gelatinous envelope present; antherid. forming hemispherical or ellipsoidal tufts on the branches; tetrasp. tetrahedral, lateral on the larger branches.

Key.

- | | |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 1. Ultimate ramuli dichotomous | 2. |
| Ultimate ramuli pinnate | 4. |
| 2. Cystoc. conical, single or in groups | 3. <i>C. Rabenhorstii</i> (3). |
| Cystoc. usually in pairs | 3. |
| 3. Secondary branches alternate, repeatedly dichotomous with fan-shaped outline..... | <i>C. corymbosum</i> (14). |
| Secondary branches arising in all directions, thickly clothed with short ramuli | <i>C. granulatum</i> (15). |
| 4. Branching perfectly distichous; minute secondary ramuli present in or near the axils of the pinnate ramuli | <i>C. tripinnatum</i> (6). |
| Branching alternate or irregular | 5. |

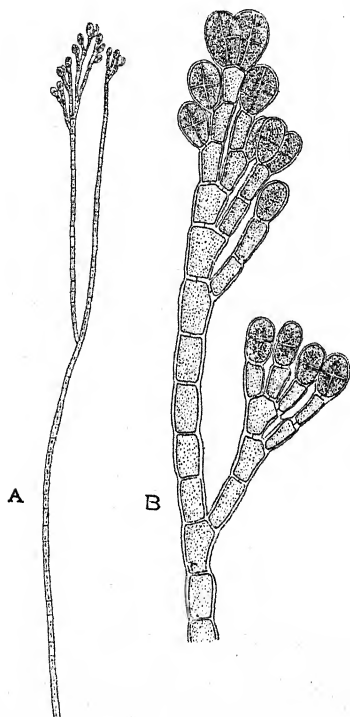


Fig. 226.—*Rhodochorton Rothii* Naeg.
A. Portion showing tetraspores ($\times 60$); B. The same ($\times 300$).

5. Ultimate branches densely clothed with tufts of alternate ramuli, each tuft consisting of corymbose alternately-branched incurved pinnules..... *C. tetragonum* (12).
- Ultimate branches not tufted 6.
6. Main axes and branches clothed throughout with irregularly divided ramuli, shaggy below, plumulate above, giving rope-like appearance to the frond *C. tetricum* (13).
- Fronds bushy 7.
7. Main axes easily distinguishable in the tuft, opaque and corticate 8.
- Main axes not easily distinguishable 10.
8. Main axes naked below for a considerable distance, cartilaginous, dark brownish purple *C. arbuscula* (11).
- Main axes clothed with ramuli throughout ... 9.
9. Ramuli usually bearing secund processes on their upper side, particularly in tetrasporic plants *C. Brodiaei* (9).
- Ramuli simple or alternately divided *C. Hookeri* (8).
10. Tetrasporang. axillary or lateral, not secund 11.
- Tetrasporang. secund 12.
11. Articulations twice as long as broad in the branches, 4 times their breadth in the ramuli; lower ramuli recurved, patent, upper ones corymbose..... *C. fruticulosum* (10).
- Articulations 3-4 times as long as broad in the branches, $1\frac{1}{2}$ times their breadth in the ramuli; the latter subulate, alternately pinnate *C. Dudresnayi* (7).
12. Tetrasporang. 1-2, rarely more, on each ramulus *C. byssoides* (2).
- Tetrasporang. secund, lining the inner side of the pinna 13.
13. Apices of the ramuli fastigiate, corymbose ... *C. tenuissimum* (1).
- Apices of the ramuli not fastigiate 14.
14. Pinnae short, subulate *C. polyspermum* (4).
- Pinnae long, more or less incurved *C. roseum* (5).

1. *C. tenuissimum* Kütz.—Fronds in gelatinous purple tufts 2-5 cm. long; primary axis bi-tripinnately branched; branches and ramuli erect, very much attenuate; apices fastigiate, corymbose; articulations of the primary axis 8-10 times as long as broad, articulations of the branches 6 times and of the ramuli 3 times their breadth. Cystoc. axillary, spherical; tetrasp. oblong, shortly pedicellate, on the inner side of the lateral branches.

Rare; widely distributed.

2. *C. byssoides* Arn. Gr. *bussos*, flax, and *eidos*, like.—Fronds rosy red, sometimes purplish or brownish; gelatinous; densely tufted, 5-10 cm. long, compound-pinnately branched; branches alternate and distichous; ramuli flexuous, once or twice pinnate, lax; articulations 6-8 times longer than broad in the branches, 4 times as long as broad in the ramuli. Cystoc. usually in pairs, generally terminal on truncated branches; tetrasporang.

elliptical, sessile, lateral on the ramuli, rarely more than 2 on each ramulus.

Not uncommon; widely distributed.

3. *C. Rabenhorstii* Crouan (*Leptothamnion Rabenhorstii* Kütz.). After L. Rabenhorst, German cryptogamic botanist.—Tufted, much branched, ultimate ramuli dichotomous. Distinguished by the conical cystocarps borne singly or in groups, and for that reason raised by Kützing to generic rank.

On *Tubularia* and epiphytic on small algæ growing on shells. Rare; Dorset.

4. *C. polyspermum* C. A. Agardh (incl. *C. Grevillei* Harv. and *C. scopulorum* Traill). Gk. *polus*, many; *sperma*, seed.—Fronds brownish red or purple, membranaceous in globose tufts, 1–5 cm. high, filaments capillary, excessively branched, corticate near the base; branches somewhat bare or furnished with numerous long, slender, somewhat zigzag secondary branchlets, bearing a second or third series of ramuli; ramuli usually short, pinnate, alternate, patent, subulate, sometimes recurved; articulations 4–5 times as long as broad in the branches, twice their breadth in the ramuli. Cystoc. in clusters, sessile on the branches; tetrasp. and antherid. borne similarly, second, on the inner sides of the ramuli, at each articulation. Sweet-smelling on being remoistened.

On various algæ, particularly *Fuci*, between the tide-marks. Common; widely distributed.

5. *C. roseum* Harv.—Fronds purple-lake or brownish, membranaceous and soft, not gelatinous; densely tufted, 7.5–10 cm. long, corticate at the base, excessively branched; branches alternate, repeatedly divided, ultimate branchlets set with alternate simple ramuli, sometimes bearing one or two secondary ramuli near the apices of the branches; articulations 4–5 times as long as broad in the main branches, gradually shorter in the branchlets and ramuli, nodes slightly swollen. Cystoc. 2 or more together, usually terminal on truncated branches; tetrasporang. elliptical, sessile on the inner side of the ramuli, second, one at each of the 4 or 5 lowermost articulations.

On rocks and the larger *Fuci*, near low-water mark, often in muddy places. Not uncommon; widely distributed.

6. *C. tripinnatum* C. A. Agardh.—Fronds dark red, delicate, not gelatinous, tufted, 2.5–5 cm. high, perfectly distichous, three times pinnated; primary branchlets having a narrow obovate outline, their lower branches short, middle ones longest, diminishing in length upwards; upper and middle branches having their upper half clothed with slender, setaceous, patent, alternate ramuli, the lower half naked, except at the basal articulation, which bears a short, often fertile, ramulus; lower branches naked, except for the short ramulus on the lowest articulation; articulations 3–4 times longer than broad in the

branches, twice their breadth in the ramuli. Tetrasporang. oval, secund along the upper edge of the ramuli, frequently also on the axillary ramulus; cyst. unknown.

On rocks at extreme low-water mark. Very rare; Devon and Roundstone.

7. **C. Dudresnayi** Crouan (*C. affine* and *C. purpurascens* Harv.). After Dudresnay de St. Pol de Leon, French collector.—Fronds deep-red, membranaceous, in tufts, 4–5 cm. long, branched from the base; main branches thickly corticate; main axis clothed with alternate branches bearing a second or third series of branchlets, the ultimate series clothed with erect, subulate, alternately pinnate ramuli; articulations 3–4 times as long as broad in the branches, $1\frac{1}{2}$ times their breadth in the ramuli. Cystoc. in pairs, on slightly distorted branches, replacing ramuli; tetrasporang. globose, usually solitary at the base of the ramuli.

Epiphytic on the *Fuci*, between the tide marks. Rare; widely distributed.

8. **C. Hookeri** C. A. Agardh (incl. *C. lanosum* and *C. spinosum* Harv.). After Sir W. J. Hooker, English botanist.—Fronds purplish or brownish red, sometimes pale pink, flaccid; densely tufted, 2.5–10 cm. long, with pyramidal outline, branches arising in all directions; main axis setaceous, corticate, set with spreading flexuous branches, some of which are corticate; branches bearing a second or third series, ultimate divisions clothed with alternate, ovate, patent, subulate ramuli, themselves once or twice pinnate, often recurved; articulations 1 or $1\frac{1}{2}$ times as long as broad in the ecorticate parts, not visible in the corticate. Cystoc. in pairs, usually terminal, on irregularly pinnate branches; tetrasporang. numerous, spherical, chiefly on the inner edges of the ramuli, one formed from each articulation.

On various algæ between the tide-marks, also on rocks near low water and at greater depth. Common; widely distributed.

9. **C. Brodiaei** Harv. After J. Brodie, Scottish collector.—Fronds brownish red, membranaceous, more or less cartilaginous, in tufts, 2.5–7.5 cm. long, pyramidal in outline; main axes corticate, furnished throughout with patent lateral branches, closely set; branches bearing a second series similar to themselves, clothed with alternate, pinnate, patent ramuli; frequently bearing a few secund process near their tips. Articulations 2–3 times as long as broad in the branches, gradually decreasing in the ramuli. Cystoc. usually in pairs, on the secondary branches; tetrasporang. oval, sessile, near the tips of the ramuli, or on their secund processes.

Epiphytic on other algæ, near low-water mark. Rare; widely distributed.

10. **C. fruticosum** J. G. Agardh. Lat. *fruticulus*, a little shrub.—Fronds in tufts, 4–6.5 cm. long, erect, corticate below; branches arising in all directions; branchlets alternately pinnate, clothed

with extrorse subulate ramuli, lowermost recurved, patent, upper ones corymbose; articulations twice as long as broad in the branches, 4 times their breadth in the ramuli. Cystoc. sub-axillary; tetrasp. on the upper ramuli, axillary or lateral.

Epiphytic on *Furcellaria*. Very rare; Dorset.

11. *C. arbuscula* Lyngb. Lat. *arbuscula*, little tree.—Fronds dark red, inclining to purple or brown, several usually arising from the same base, 5–15 cm. long, naked below, branched and attenuate upwards, corticate. Main branches cartilaginous, arising on all sides, bearing similar lateral branches, spreading and forming a bushy head; lesser branches clothed with minute, imbricated, pinnated ramuli, making each branchlet cylindrical, and giving the apices a blunt corymbose aspect; ramuli flaccid, clothed with alternate, simple or once forked, patent or reflexed pinnules; articulations visible in the ramuli, twice as long as broad. Cystoc. in pairs or clustered on the ramuli; tetrasporang. sessile, spherical, secund, on the inner surface of the pinnules.

On rocks and mussel shells, near low-water mark, usually in places left bare by the receding tide; also in pools. Common; N. England, Scotland, and W. Ireland.

12. *C. tetragonum* C. A. Agardh. Gk. *tetras*, four; *gonia*, angle.—Fronds brownish red, cartilaginous to membranaceous, 5–12.5 cm. long, with broadly ovate outline; main axes smooth or clothed with short hair-like processes, corticate below, bearing numerous lateral, patent, alternate branches, the lowermost being longest; branches bear a second or third series of smaller branches, all simple; ultimate branches densely clothed with tufts of alternate ramuli, each tuft consisting of corymbose, alternately branched pinnules, incurved, attenuate at base and apex; articulations 2–3 or rarely 4 times as long as broad in the main axes and branches, $1\frac{1}{2}$ times their breadth in the ramuli. Cystoc. usually in pairs, on the tufts of ramuli; tetrasporang. very minute, oval or oblong, near the tips of the ramuli, one or two on each ramulus.

Epiphytic on the larger algæ; particularly on the fronds of *Laminaria digitata*. Not uncommon; widely distributed.

var. *brachiatum* J. G. Agardh. (*Callithamnion brachiatum* Harv.)—Ultimate ramuli subulate. Frequent; widely distributed.

13. *C. tetricum* C. A. Agardh. Lat. *tetricus*, harsh.—Fronds dark brownish, rigid, tufted, 5–20 cm. long, rising from a large disc densely covered with interwoven filaments; main axes and branches corticate, densely covered with ramuli, shaggy below, plumulate above; branches irregularly alternate, bearing branchlets of the first or second order, the whole clothed with ramuli; plumulate ramuli long, simply alternately pinnate, pinnæ erect, attenuate at base and apex; articulations about twice as long as broad, somewhat constricted at the nodes.

Cystoc. in pairs on the pinnæ; tetrasporang. 2 or 3 together, elliptical, minute, sessile on the inner sides of the pinnæ.

On the perpendicular faces of rocks within the tide-marks, from half-tide level to low-water mark. Common; S. England, S.E. and W. Ireland, and Channel Islands.

14. *C. corymbosum* Lyngb. (incl. *C. versicolor* C. A. Agardh).

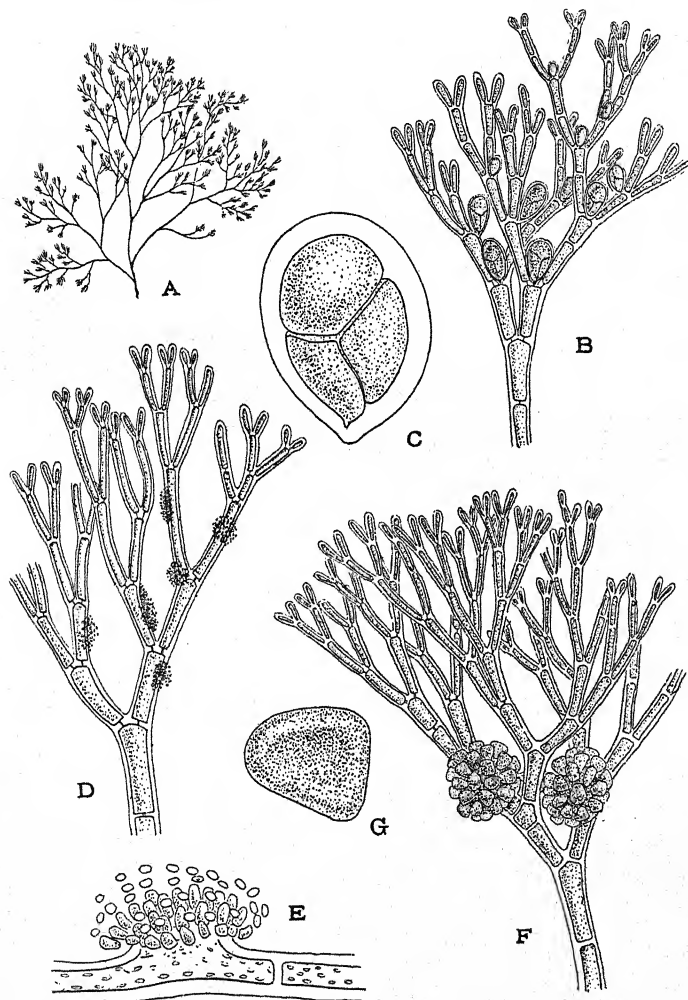


Fig. 227.—*Callithamnion corymbosum* Lyngb. A. Plant ($\times 1$); B. Portion bearing tetrasp. ($\times 60$); C. Single tetrasporang. ($\times 300$); D. Portion of antheridial plant ($\times 60$); E. The same ($\times 300$); F. Frond with cystocarps ($\times 60$); G. Single carpospore ($\times 300$).

Gr. korumbos, a cluster of berries.—Fronds rosy-red, very tender, flaccid and gelatinous, densely tufted, 2.5–7.5 cm. long; excessively branched, corticate at the base; secondary branches alternate, repeatedly dichotomous, with fan-shaped outline; ramuli repeatedly dichotomous, corymbose; articulations as much as 10 times as long as broad in the main branches, 3–4 times their breadth in the ramuli. Cystoc. usually in pairs, terminating the secondary branches, sometimes surrounded by a few forked ramuli; antherid. in ellipsoidal tufts on the branches; tetrasporang. solitary, sessile, lateral, just below the dichotomous branching of the ramuli.

On leaves of *Zostera*, fronds of various algæ, and attached to rocks and stones, near low-water mark. Not uncommon; widely distributed.

15. *C. granulatum* C. A. Agardh (*Callithamnion spongiosum* Harv.)—Fronds dull purplish or brownish red, flaccid, membranaceous, but not gelatinous, tufted, 5–10 cm. long, with conical outline, corticate below; main axes branched in all directions, thickly clothed with short ramuli; branches thickly set with a second or third series of branchlets; ramuli repeatedly dichotomous, axils patent; articulations 2–3 times as long as broad, somewhat constricted in the centre. Cystoc. usually in pairs, on the apices of the branchlets, often surrounded by 2 or 3 dichotomous ramuli; tetrasporang. elliptical, solitary, sessile in the forking of the ramuli.

On perpendicular rocks near low-water mark, and epiphytic on other algæ. Not uncommon; widely distributed.

12. *SEIROSPORA* Harv.

(*Gr. seira*, a chain, and *sporos*, a seed.)

Fronds erect, corticate in the main branches, monosiphonous. Antherid. in tufts on the outer side of short branches; cystocarps without gelatinous envelope; tetraspores tetrahedral; seirospores present.

Differing from *Callithamnion* in the form of the cystoc. and also in possessing uninucleate cells instead of multinucleate as in *Callithamnion*. In *Seirospora* the gonimoblast consists of branched clusters of sporogenous filaments, while in *Callithamnion* there are rounded many-celled gonimolobes springing from a small central cell.

Key.

- | | |
|---------------------------------|------------------------------|
| 1. Branches patent..... | <i>S. Griffithsiana</i> (1). |
| Branches fastigiate..... | 2. |
| 2. Tetrasporang. axillary | <i>S. interrupta</i> (2). |
| Tetrasporang. lateral..... | <i>S. hormocarpa</i> (3). |

1. *S. Griffithsiana* Harv. After Mrs. Griffiths, British algologist.—Fronds rose-red, gelatinous; solitary or slightly tufted, 2.5–7.5 cm. long, usually with a conspicuous corticate main axis, from which numerous simple, alternate, patent

branches arise; general outline of the frond pyramidal; larger branches sometimes bearing a second series of branchlets, all furnished with sub-dichotomous, multifid ramuli, somewhat corymbose; articulations 2-4 times longer than broad, somewhat swollen upwards. Cystoc. composed of radiating chains of spores, without gelatinous envelope; antherid. in tufts on short branchlets; tetrasporang. sessile or on a one-celled stalk on the upper branchlets; seirospores oval, in moniliform tufts at the end of the branchlets.

On rocks and stones, in 4-6 fathoms. Rare; widely distributed.

2. *S. interrupta* Schmitz (*Callithamnion interruptum* C. A. Agardh).—Fronds flaccid, erect, corticate below, alternately branched; branches arising on all sides, clothed with ramuli; upper ramuli dichotomous, incurved, long or short. Tetrasp. cruciate, shortly pedicellate or rarely sessile, axillary, ellipsoidal; seirospores present.

Very rare; S. England.

3. *S. hormocarpa* Batt. (*Callithamnion hormocarpum* Holm., *C. byssoides* f. *seirosporifera* Holm. & Batt.). Gr. *hormos*, necklace, and *karpon*, a fruit.—Frond pinkish purple, capillary, densely tufted, 2.5-5 cm.

high, not glossy, alternately branched; articulations at the base of the frond clothed with branched articulated filaments, articulations of the branches 6-8 times as long as broad, those of the ramuli 4 times, decreasing to twice; ramuli flexuose and attenuate at the apices, simple, once or repeatedly forked and tufted at the apices, axils very narrow. Seirospores on the secondary branches and ramuli, never on terminal branches; tetraspores elliptical, lateral.

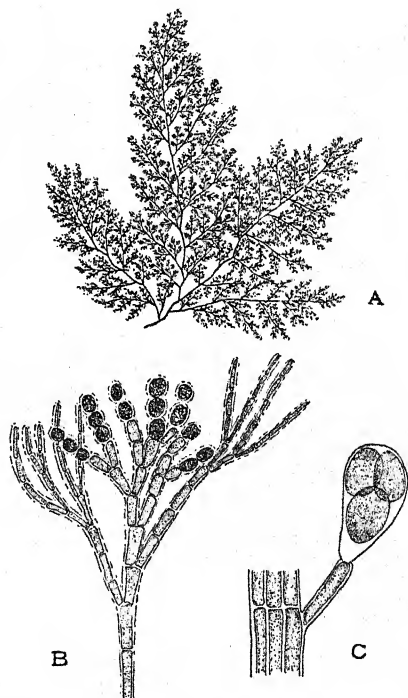


Fig. 228.—*Seirospora Griffithsiana* Harv. A. Plant ($\times \frac{1}{2}$); B. Tip of branch bearing moniliform seirospores ($\times 66$); C. Tetrasporang. borne on a single-celled stalk arising from a corticate branch ($\times 300$).

Epiphytic on the Fuci at low-water mark. Very rare; S. England.

13. COMPSOTHAMNION Schmitz

(Gr. *komposos*, elegant, and *thamnion*, a small bush.)

Thallus monosiphonous, ecorticate; much branched, branching regular, alternate, distichous. Cystoc. without involucrel branches, formed of one or two gonimoblasts, becoming lobed, the lobes ripening and producing carpospores simultaneously; tetrasp. tetrahedral, terminal on the ramuli.

Key.

Branching more or less irregular; articulations of the main axis 3-4 times their breadth; main branches unequally but closely plumate
Branching very regular, perfectly distichous; articulations of the main axis 2-6 times their breadth

C. gracillimum

C. thuyoides

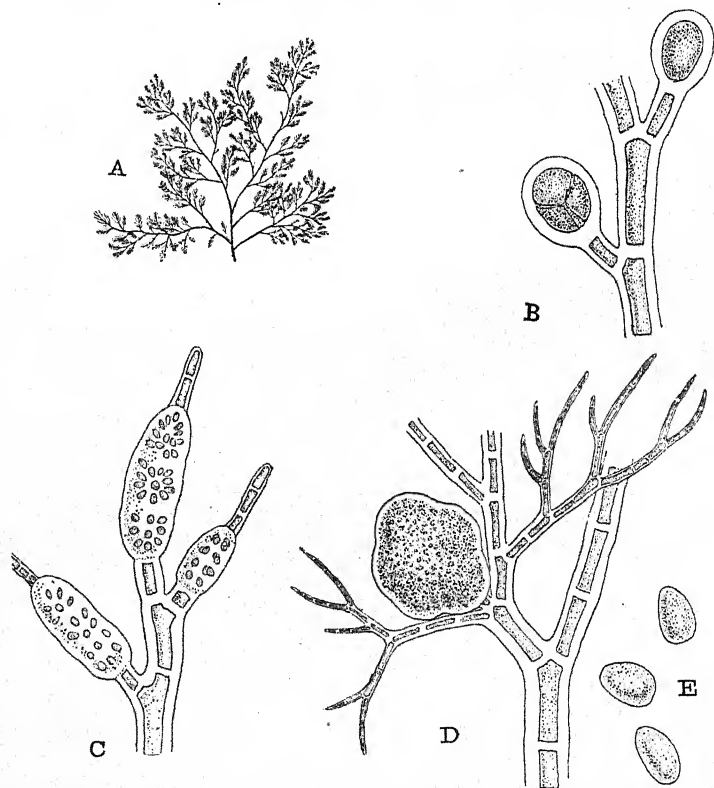


Fig. 229.—*Compsothamnion gracillimum* De Toni. A. Plant ($\times 3$); B. Tetrasporic branch ($\times 60$); C. Antheridial branch ($\times 60$); D. Cystocarpic branch ($\times 60$); E. Carpospores ($\times 300$).

C. thuyoides Schmitz (*Callithamnion thuyoides* C. A. Agardh). *Thuja*, a genus of Coniferæ, and Gr. *eidos*, like.—Fronds rose-pink or brownish red, delicate, membranaceous, soft and flaccid, 2.5–7.5 cm. long, densely tufted; main axis clothed with alternate, repeatedly pinnate branches, with narrow lanceolate outline; branches clothed with regularly pinnate branchlets bearing pinnate or bipinnate ramuli; each plumate branchlet linear-lanceolate in outline; articulations of the stem and branches usually 4–6 times as long as broad, occasionally shorter. Cystoc. solitary or in pairs, lobed; tetrasporang. minute, globose, terminal on the ultimate ramuli.

On rocks near low-water mark. Rare; widely distributed.

C. gracillimum De Toni (*Callithamnion gracillimum* Harv.). Lat. *gracillimus*, most graceful.—Fronds deep red, delicate, membranaceous, flaccid, tufted, 2.5–10 cm. long, very slender, distichous, irregularly branched; main branches few, 2.5–5 cm. long, unequally but closely plumate along their whole length; lower plumules short, irregularly pinnate, upper ones elongate, lanceolate, spreading, bi-tripinnate; branches and ramuli alternate, usually arising from every articulation. Cystoc. irregularly lobed, borne on the branchlets; tetrasporang. minute, ellipsoid or roundish, on the tips of the ultimate ramuli.

On mud-covered perpendicular rocks near low-water mark. Rare; widely distributed.

14. PLUMARIA Stackh.

(Lat. *pluma*, a soft feather.)

Thallus filamentous, much branched, many times pinnated with opposite ramuli; corticate below, ecorticate above, monosiphonous throughout. Cystoc. terminal, surrounded by involucrel ramuli, longer than normal ramuli; tetrasp. tetrahedral, terminal on the ramuli.

P. elegans Schmitz (*Ptilota sericea* Harv.).—Fronds dark blackish or brownish red, soft and flaccid, tufted, 5–10 cm. long or more, excessively branched, distichous; main divisions sometimes dichotomous, otherwise alternate, ultimate branchlets and ramuli opposite; secondary branches elongate, repeatedly and closely pinnate; branchlets and ramuli nearly horizontal, of irregular length; ultimate ramuli very closely set, those on the outer side longer than the inner, linear, blunt, slightly curved. Cystoc. on the apices of shortened branchlets, naked or surrounded by an involucre of ramuli. Tetrasporang. spherical.

On the perpendicular faces of rocks, between the tide-marks, particularly near low-water mark; hanging in brownish tassels after the tide has receded. Rarely epiphytic. Common; widely distributed.

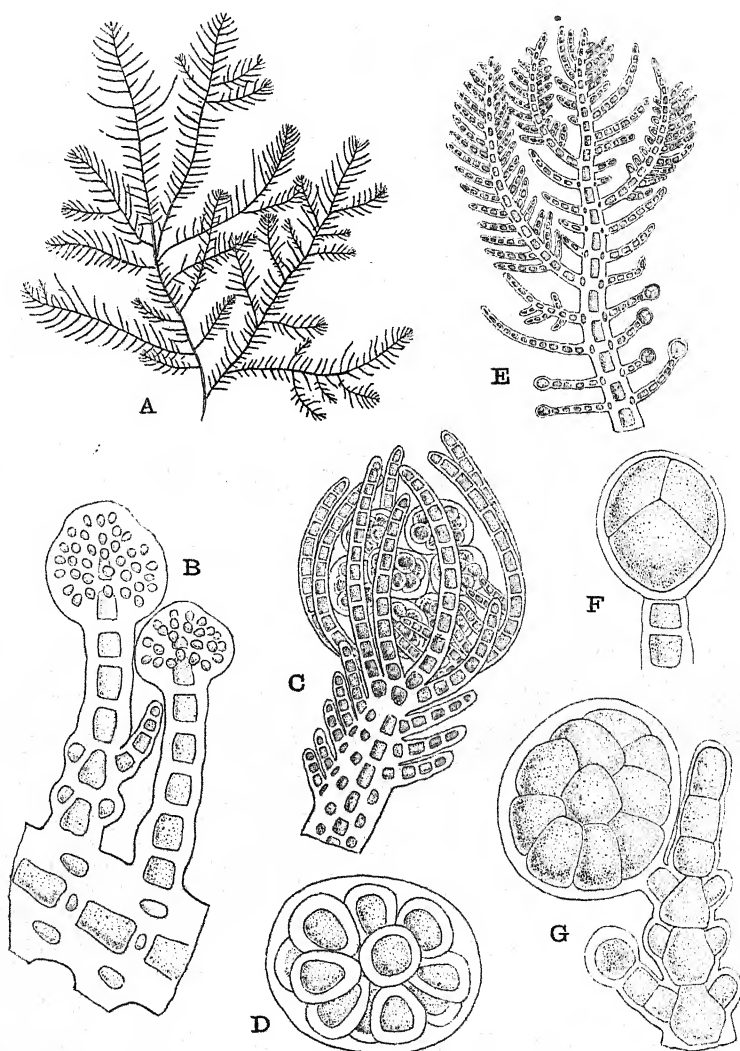


Fig. 230.—*Plumaria elegans* Schmitz. A. Plant ($\times \frac{2}{3}$); B. Antheridial ramuli ($\times 300$); C. Cystocarpic branch ($\times 100$); D. Lobe of cystocarp ($\times 300$); E. Tetrasporic ramuli ($\times 60$); F. Single tetrasporang. ($\times 300$); G. Polysporangium ($\times 300$).

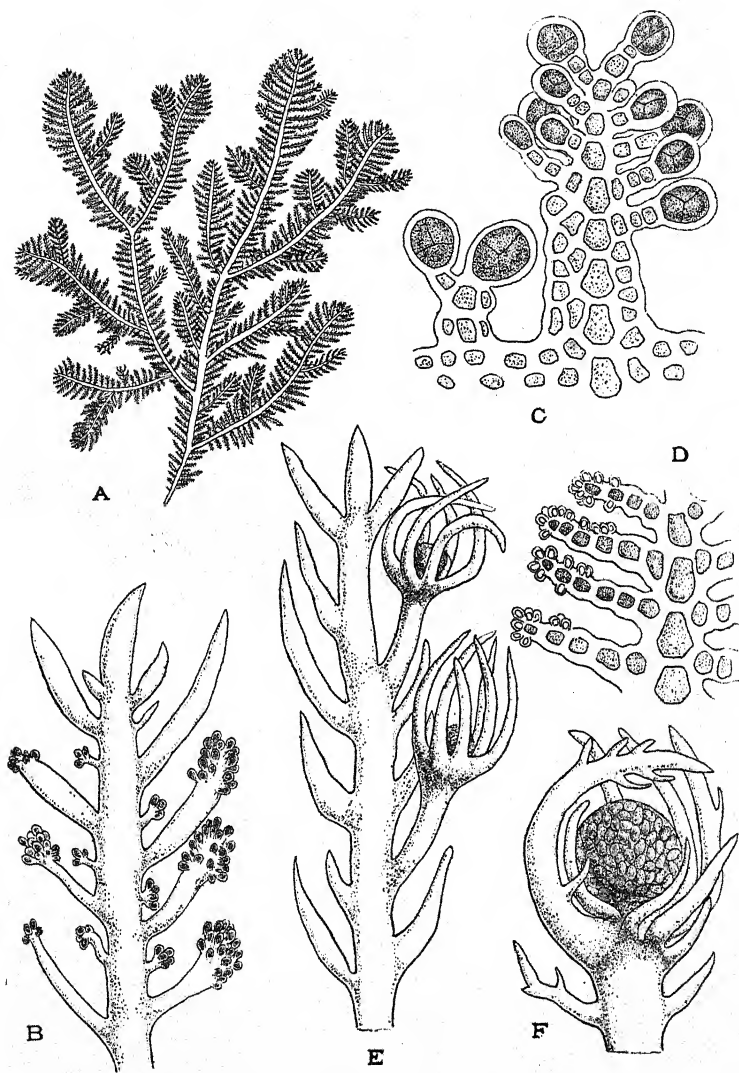


Fig. 231.—*Ptilota plumosa* C. A. Agardh. A. Plant ($\times \frac{3}{4}$); B. Tetrasporic ramuli ($\times 90$); C. The same ($\times 300$); D. Antheridial ramuli ($\times 300$); E. Cystocarpic branch ($\times 33$); F. Cystocarp with enveloping ramuli ($\times 60$).

15. **PTILOTA** C. A. Agardh(Gr. *ptílos*, winged.)

Frond compressed, erect, branches distichous, pectinate-pinnate, composed of a monosiphonous axis, and a cortical flange of smaller cells. Cystoc. terminal on the branches, usually surrounded by an involucre of ramuli; tetrasporang. pedicellate, fringing the margin of the smaller pinnules.

P. plumosa C. A. Agardh. Lat. *plumosus*, feathered.—Fronds dark full red, often with a brownish tinge particularly in the main branches, cartilaginous, rather rigid, tufted, 10–30 cm. long, compressed, linear, irregularly branched; secondary branches distichous, patent, linear-oblong or obovate in outline, bi-tripinnate; pinnæ and pinnules patent, very close, longest in the middle part of the branch; ultimate ramuli closely pectinate, subulate, acute; pinnæ and pinnules exactly opposite. Cystoc. at the apices of the pinnules, surrounded by an involucre of ramuli; tetrasporang. pedicellate, fringing the margin of the pinnules, borne on separate plants.

Epiphytic on the stipes of *Laminaria digitata*. Very common; Scotland, N. England, N. and W. Ireland.

The *P. plumosa* of the old Floras of Cornwall, Devon, Dorset, Hants, Sussex, Kent, and Norfolk must be referred to *Plumaria elegans*, formerly regarded as a variety of *P. plumosa*. *Plumaria elegans* may be distinguished by its ecorticate ramuli.

16. **ANTITHAMNION** Naeg.(Gr. *anti*, opposite, and *thamnion*, a small bush.)

Filaments monosiphonous; ramuli opposite or whorled, ecorticate. Cystoc. appearing terminal on the branchlets; tetrasporang. oval, cruciate, sessile or stalked, replacing the ultimate ramuli.

Key.

- | | |
|------------------------------------------------------------------------------|--------------------------|
| 1. Ramuli opposite..... | 2. |
| Ramuli secund, borne on the inner side | <i>A. plumula</i> (2). |
| 2. Crowded undeveloped ramuli terminating the branches, densely tufted | <i>A. cruciatum</i> (1). |
| Branches not tufted at their apices, plant lax | <i>A. floccosum</i> (3). |

A. cruciatum Naeg. (*Callithamnion cruciatum* C. A. Agardh). Botan. Lat. *cruciatum*, cross-shaped.—Filaments brownish-red, flaccid, 2.5–5 cm. long, densely tufted, irregularly and sparingly branched; branches clothed with short lateral branchlets, furnished with slender, opposite, or quaternate and cruciate ramuli; erect, straight, not markedly attenuate; apices of the branches dense and tufted, owing to the crowding of undeveloped ramuli; articulations of the main axes and branches 2–4 times

as long as broad, of the branchlets 2-3 times their breadth, of the ramuli twice their breadth. Tetrasporang. sessile or shortly pedicellate, elliptical, replacing the lower ramuli on the branchlets.

On mud-covered rocks near low-water mark. Rare; widely distributed.

var. **pumilum** Harv. Smaller than the type, ramuli more dense, articulations shorter. Rare; S. England and Ireland.

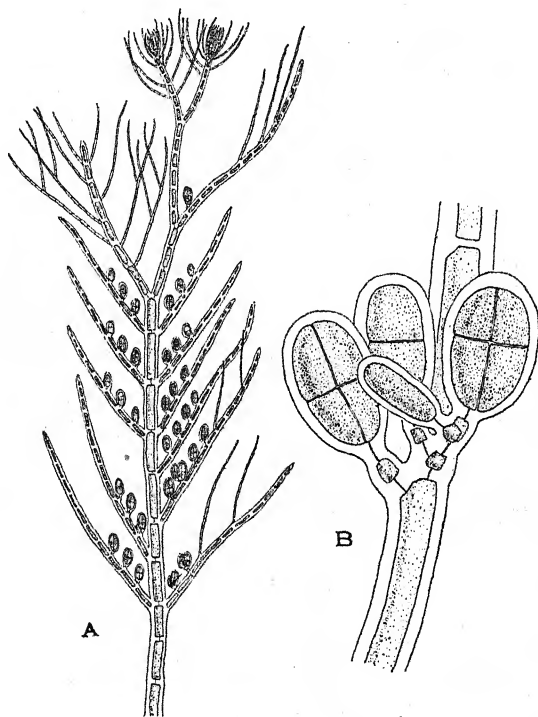


Fig. 232.—*Antithamnion cruciatum* Naeg. A. Tetrasporic thallus ($\times 33$); B. Group of developing tetrasp. ($\times 300$).

2. **A. plumula** Thur. Lat. *pluma*, a soft feather (*dimin.*).—Filaments red or brownish, soft and tender, densely tufted, 2.5-15 cm. long, distichously branched; branches alternate or dichotomous, repeatedly divided, each articulation throughout the plant bearing a pair of slender opposite branchlets (in luxuriant specimens branchlets may occur in fours); branchlets horizontally placed or reflexed, pectinated or bi-tripectinated along their upper surfaces with articulated ramuli, longest near the axil of the branchlet. Cystoc. densely clustered, terminating

the main branches; tetrasporang. on the tips of the ultimate ramuli.

On rocks and algæ, near low-water mark, and in 4-15 fathoms of water. Not uncommon; widely distributed.

var. **crispum** J. G. Agardh.—Branches in verticillate groups of 4; pinnules closer than the type, divaricate. Rare; S. England and Channel Islands.

3. **A. floccosum** Kleen (*Callithamnion floccosum* C. A. Agardh). Lat. *floccosus*, woolly.—Filaments brownish red, flaccid, densely tufted, 2.5-10 cm. long, irregularly branched, alternate or subdichotomous; branches few and widely distant; main branches naked or furnished with short, closely branched, lateral, secondary branches with an obovate outline; all the divisions alternate, axils acute, branches and ramuli erect or somewhat patent; articulations throughout the plant bearing a pair of opposite, simple, subulate ramuli; articulations 2-4 times as long as broad. Tetrasporang. elliptical, shortly pedicellate, on either side of the ramuli.

On rocks, near low-water mark. Very rare; N. Scotland.

17. ANTITHAMNIONELLA Lyle

(From its near relationship to *Antithamnion*.)

Plants monosiphonous and filamentous, with irregular alternate and indefinite ramification. Articulations bearing whorls of 2 to 4 ramuli at the nodes, crowded towards the extremities. In older parts, one or more ramuli may be replaced by discoid rhizoids. Tetrasporang. solitary, ovoid, sessile on the inner side of the ramuli near their origin, tetrahedral; cystoc. bilobed.

A. sarniensis Lyle. Lat. *Sarnia*, Guernsey.—Thallus deep rose-red, 2.5 to 4 cm. high, tufted or plumose; main branches widely divergent, bearing at first irregular and then alternate, secondary branches; articulations bearing 2-3, rarely 4, ramuli in a whorl, any of which may be replaced by a discoid non-septate rhizoid; cells of the main branches 70-190 μ by 50-60 μ , cell-wall thick and laminated. Antherid. and cystoc. unknown.

In rock-pools. Guernsey.

18. HYMENOCOLONIUM Batt.

(Gr. *humen*, membrane, and *klon*, young shoot.)

Fronds minute, adhering by the entire under-surface; branches opposite, frequently anastomosing, united by a hyaline membrane into a pseudoparenchymatous expansion; tetraspores cruciate, formed from the cells of the main axis.

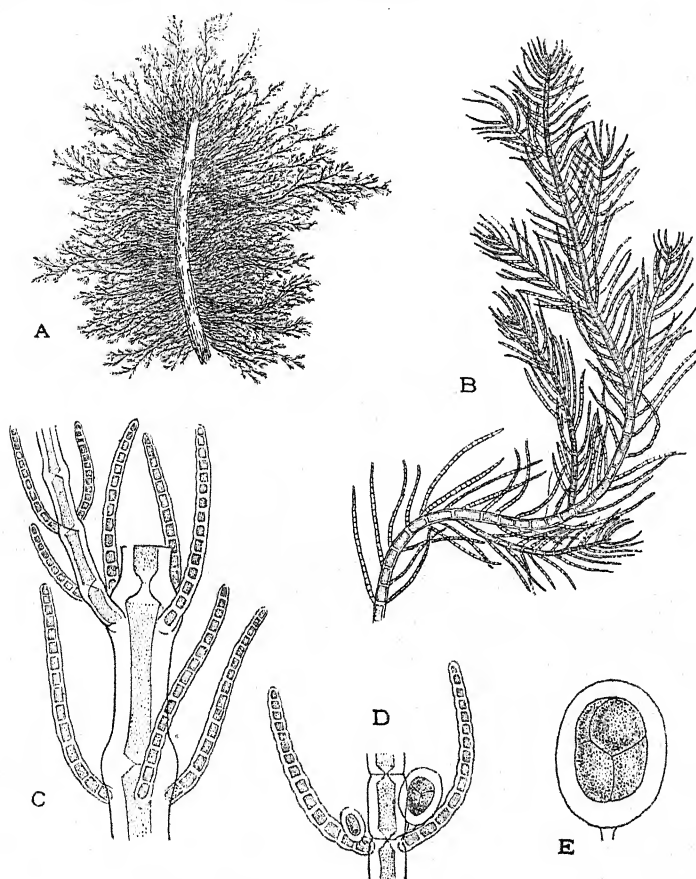


Fig. 233.—*Antithamnionella sarniensis* Lyle. A. Plant ($\times 1$); B. Portion of thallus ($\times 60$); C. Portion of the same ($\times 140$); D. Tetrasporang. at base of ramuli ($\times 140$); E. Single tetrasporang. ($\times 300$).

H. serpens Batt. (*Callithamnion serpens* Crouan). Lat. *serpere*, to creep.—Fronds rose-red or pink, 2–4 mm. in length, bipinnate; upper portion of the main branches often naked; cells of the main axes $35\text{--}40\mu$ by $10\text{--}12\mu$, those of the secondary branches $10\text{--}20\mu$ by $8\text{--}10\mu$ or more broad; apical cells of the main axes rounded, those of the secondary branches often attenuate.

Creeping on the surface of stone or broken glass. Very rare; Plymouth.

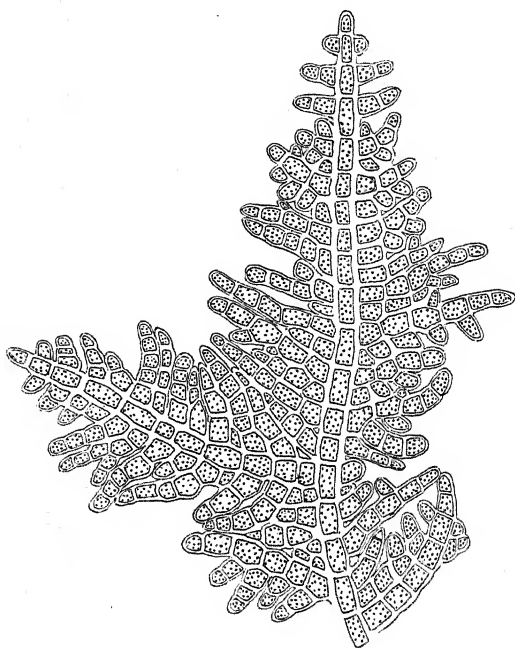


Fig. 234.—*Hymenoclonium serpens* Batt. Portion of creeping thallus ($\times 300$).

19. CROUANIA J. G. Agardh

(After the brothers Crouan, French algologists.)

Frond gelatinous, filiform, monosiphonous; articulations bearing whorls of minute, multifid, monosiphonous ramuli. Cystoc. solitary or in pairs, borne near the base of the whorled ramuli; tetrasp. on distinct individuals, obovate, on the lower parts of the ramuli.

C. attenuata J. G. Agardh. Lat. *attenuatus*, thinned.—Fronds brownish or purplish red, very tender and gelatinous. Densely tufted, 2.5–5 cm. long, excessively branched and bushy; branches alternate, many times divided, patent, moniliform, attenuate above, clothed throughout with dense globular whorls of dichotomous multifid ramuli, arising at the nodes; articulations several times longer than broad in the lower parts, gradually shorter upwards. Tetrasporang. sessile; tetrasp. tetrahedral.

Epiphytic on the smaller algæ. Very rare; S. England and Channel Islands.

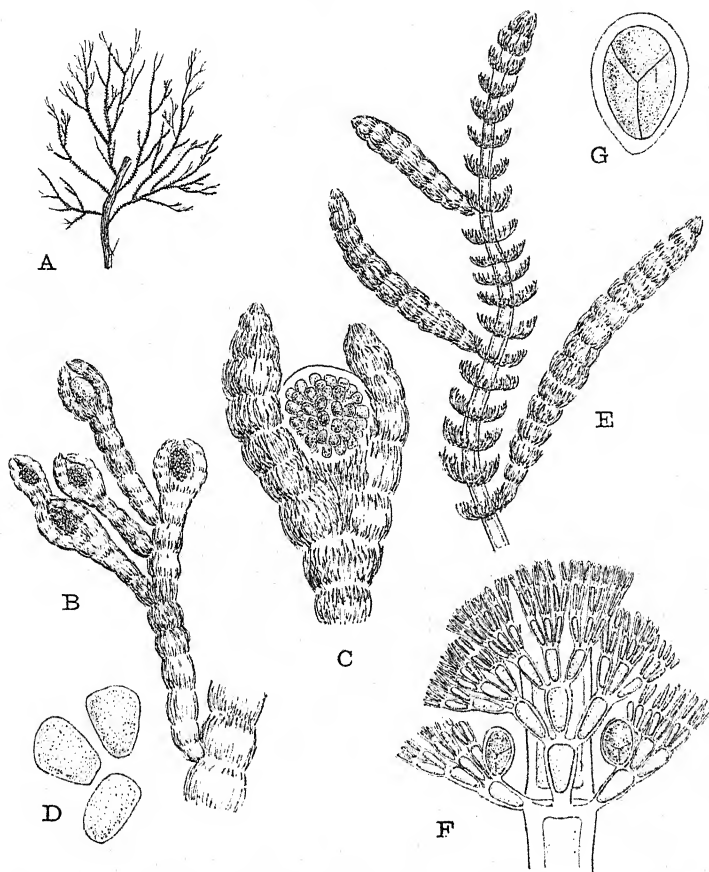


Fig. 235.—*Crouania attenuata* J. G. Agardh.—A. Plants ($\times \frac{3}{2}$); B. Portion of cystocarpic plant ($\times 40$); C. Portion of the same ($\times 140$); D. Carpospores ($\times 300$); E. Portion of tetrasporic frond ($\times 40$); F. Small portion of same showing tetraspores ($\times 200$); G. Single tetrasporang. ($\times 300$).

20. SPYRIDIA Harv.

(Gr. *spuris*, *spuridos*, a basket.)

Main branches cylindrical, much branched, monosiphonous, corticate in the older parts; ramuli short, usually simple, borne all round the axes without definite arrangement. Cystoc. stalked, gelatinous, in groups on the branchlets, surrounded by an involucre of ramuli; tetrasporang. on separate individuals, spherical, sessile on the ramuli.

S. filamentosa Harv.—Frond dull red, often faded, cartilaginous in the main axes, membranaceous in the ramuli; attached by a large disc, 1.25 cm. or more in diam., tufted, from 5–25 cm. high; branches irregular, gradually attenuate upwards;

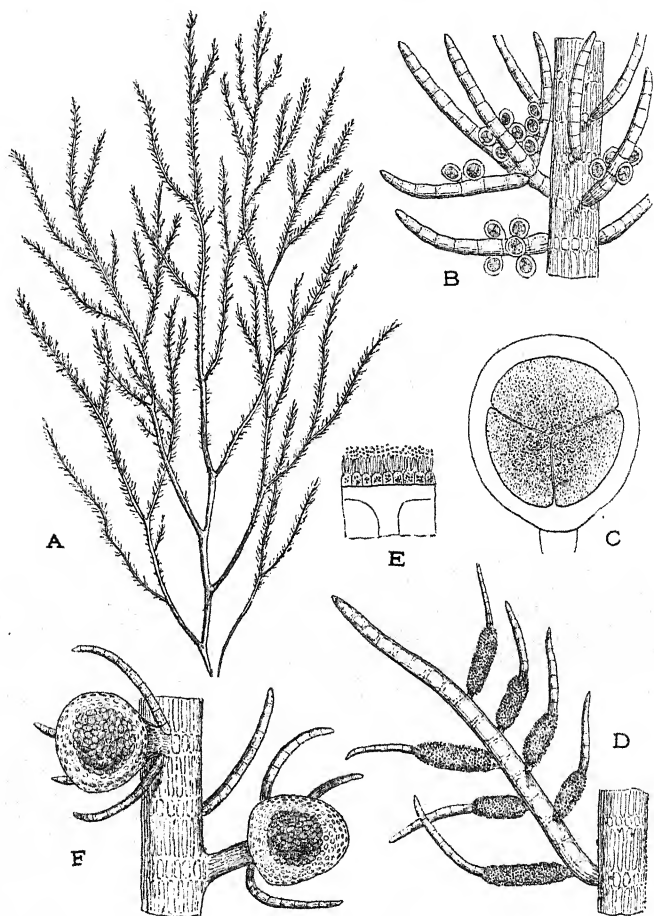


Fig. 236.—*Spyridia filamentosa* Harv. A. Plant ($\times \frac{3}{2}$); B. Portion of tetrasporic frond ($\times 33$); C. Single tetrasporang. ($\times 300$); D. Portion of antheridial frond ($\times 33$); E. Section of same ($\times 300$); F. Cystocarp ($\times 33$).

main axis either simple or forked, bearing numerous lateral branches; younger portions of the frond beset with articulated ramuli, arising from all sides of the branches; older parts corticate, ramuli ecorticate.

On rocks near low-water mark. Locally abundant; S. and W. England; unknown in Scotland and Ireland.

21. CERAMIUM Lyngb.

(Gr. *keramion*, a vessel.)

Frond filiform, monosiphonous, composed of a series of large ovate or rectangular cells, with bands of corticating cells at the nodes, sometimes extending over the internodes; branching dichotomous or subpinnate, apices of the branches usually forcipate. Antherid. forming sessile patches on the upper branches; cystoc. sessile at the nodes, usually within an involucre of branchlets; tetrasp. tetrahedral, in the corticating cells; paraspores present in some species, formed from the corticating cells at the nodes.

The development of the cortication is a useful aid to the determination of species. Fig. 239 shows a type of cortication in which the growth of the corticating cells at the node has been in an upward direction. Fig. 238 shows a type in which the growth of the corticating cells has been mainly in a downward direction. In other species growth of the corticating cells takes place in both upward and downward directions.

Key.

- | | |
|--------------------------------------------------------------------------------------------------------|--------------------------------|
| 1. Frond spiny | 2. |
| Spines absent | 5. |
| 2. Thallus completely corticate | <i>C. flabelligerum</i> (17). |
| Thallus with hyaline bands between the corticated nodes..... | 3. |
| 3. Spines triangular, consisting of more than one cell | 4. |
| Spines elongated, acicular, unicellular | <i>C. echinotum</i> (18). |
| 4. Spines borne in whorls at each node | <i>C. ciliatum</i> (19). |
| One subulate acute spine borne on the outer side of each node | <i>C. acanthotum</i> (20). |
| 5. Branches at least in parts completely corticate | 11. |
| Branches corticated only at the nodes | 6. |
| 6. Number of articulations 7 to 15 in each ramification | 7. |
| Number of articulations many more than 15 in each ramification | 10. |
| 7. Tufts perfectly fastigiate, substance soft | <i>C. fastigiatum</i> (4). |
| Not perfectly fastigiate..... | 8. |
| 8. Paraspores absent | <i>C. tenuissimum</i> (2). |
| Paraspores present | 9. |
| 9. Intervals between the articulations more than 4 or 5 times the length of the corticating zone | <i>C. diaphanum</i> (5). |
| Intervals between the articulations 10 times the length of the corticating zone | <i>C. strictum</i> (3). |
| 10. Extreme apices of the branches not forcipate | <i>C. Deslongchampsii</i> (6). |
| Extreme apices of the branches forcipate | <i>C. gracillimum</i> (1). |
| 11. Axis appearing banded | 12. |
| Axis not appearing banded | 14. |

- | | |
|--------------------------------------------------------------------------------------------------------------------|------------------------------|
| 12. Lower nodes distant, upper nodes closer | <i>C. arborescens</i> (8). |
| No marked difference between the length of internode in different parts of the thallus | 13. |
| 13. Cortication consisting of small angular cells giving a reticulate appearance..... | <i>C. rubrum</i> (13). |
| Cortication consisting in the internodes of elongated cells parallel to the long axis of the thallus | <i>C. vimineum</i> (10). |
| 14. Corticating zones becoming decurrent by downward proliferation only | <i>C. circinatum</i> (7). |
| Corticating zones becoming decurrent by upward only or upward and downward proliferation | 15. |
| 15. Branching alternately pinnate..... | 16. |
| Branching dichotomous | 17. |
| 16. Corticating zones becoming continuous by upward proliferation only | <i>C. fruticulosum</i> (9). |
| Corticating zones becoming continuous by upward and downward proliferation | <i>C. pennatum</i> (15). |
| 17. Branches clothed with short ramuli, attenuate at each extremity | 18. |
| Ramuli few | 19. |
| 18. Cystocarps without involueral ramuli; corticating cells of the internode arranged in longitudinal chains | <i>C. botryocarpum</i> (11). |
| Cystocarps with involueral ramuli: corticating cells of the internode reticulately disposed | <i>C. tenue</i> (12). |
| 19. Tetrasporang. in a double series at the node... .. | <i>C. secundatum</i> (14). |
| Tetrasporang. in a single series at the node, few in number | <i>C. Derbesii</i> (16). |

1. *C. gracillimum* Harv. Lat. *gracillimus*, very slender.—Fronds dark reddish-purple, exceedingly tender and gelatinous, densely tufted, 2–14 cm. long, irregularly dichotomous or somewhat alternately divided; filaments, 120–170 μ broad at the base, with alternate dichotomous ramuli, often corymbose; apices incurved but not strongly hooked; articulations many times longer than broad in the lower parts, gradually shorter upwards, not as long as broad in the ramuli. Cystoc. either on lateral ramuli or truncated branches, globose, often in pairs, surrounded by elongated, forked, involueral ramuli.

On the shells of *Mytilus*, on *Corallina officinalis* and other small algæ. Rare; S. England, Norfolk and Ireland.

2. *C. tenuissimum* J. G. Agardh (*C. nodosum* Harv.). Lat. *tenuissimus*, very thin.—Fronds brownish-red, rigid and harsh to the touch when fresh, soon becoming flaccid, forming dense globular tufts, 2–6 cm. long; filaments very slender, 80–200 μ broad at the base, regularly dichotomous, more or less furnished in the upper part with short ramuli; axils very patent, sometimes divaricating, apices hooked inwards; articulations 5–6 times as long as broad in the lower and middle branches, 3 times their breadth in the upper, gradually diminishing upwards; articulations smooth, nodes globose, swollen, corticate. Cystoc. at the apices of the ultimate ramuli; tetrasp. in the corticating cells of short lateral ramuli.

On sandy shores, often among the roots of *Zostera*. Locally abundant; widely distributed.

var. *arachnoideum* C. A. Agardh.—Frond capillary, apices attenuate, regularly dichotomous, fastigate, terminal segments erect and patent, apices converging, lower articulations 3-4 times longer than broad. Tetrasporang. scattered on the filament, singly or in groups at the nodes. Rare; Jersey.

3. *C. strictum* Harv. Lat. *strictus*, drawn together.—Filaments dark purplish red, delicately membranaceous and soft, capillary, densely tufted, 5-10 cm. long, of nearly equal diameter throughout, dichotomous, without conspicuous main axis, but sometimes furnished with occasional lateral ramuli, the bases of the tufts entangled with attachment rhizoids; lower bifurcations distant, upper gradually closer, ultimate branches corymbose; branches straight, erect, axils acute and narrow, apices incurved but not strongly involute; articulations 3-4 times their breadth in the middle and lower portions, twice as long as broad in the upper, much shorter than their breadth in the ultimate branches; nodes articulate, slightly swollen, quite smooth or clothed with long slender hairs when young; cystoc. often in the axils of the branches, subtended by a few short ramuli; tetrasporang. forming a whorl in the cortication of the upper (but not ultimate) branches; paraspores formed from the corticating cells at the nodes.

On mussel-shells, corallines, etc., in tide-pools near low-water mark. Not uncommon; widely distributed.

var. *delicatum* J. G. Agardh.—Internodes more elongated than the type, penultimate branches fertile, almost moniliform. Rare; Cornwall and Devon.

4. *C. fastigiatum* Harv. Lat. *fastigium*, a gable.—Fronds tender and flaccid, densely tufted, dark purple in the tuft; filaments 10-12.5 cm. long, fastigate, many times dichotomous, regularly forked throughout, usually without lateral branchlets but occasionally with a few simple or forked ramuli; lower axils distant, somewhat patent, upper ones close together and narrow, acute; apices usually emarginate, slightly curved but not rolled inwards; filaments 80-200 μ broad, of nearly equal diam. throughout; articulations 3-6 times as long as broad, slightly corticate at the nodes, upper articulations gradually shorter, the uppermost not as long as broad. Cystoc. sessile near the apex of the frond, having a few short involucreal ramuli.

On rocks, etc., near low-water mark. Rare; S. and W. England and Firth of Forth.

5. *C. diaphanum* Roth. Gr. *diaphanes*, transparent.—Fronds brownish red or purplish, soft but rather firm. Not very densely tufted, 7-20 cm. long, filaments setaceous at the base, gradually attenuate upwards, more or less regularly dichotomous or alternately divided with a main axis; branches

naked or clothed with slender, forked or several times dichotomous short ramuli; apices hooked but not inrolled. Filaments 300–450 μ or more in breadth at the base; articulations 4–5 times longer than broad in the lower parts, gradually shorter upwards, shorter than broad in the ramuli. Lower axils distant, patent; upper ones gradually closer and more erect. Cystoc. sessile in the upper axils or borne on lateral pedicels, surrounded by an involucre of 4 or 5 short incurved ramuli; tetrasp. immersed in the cortication at the nodes, arranged in a whorl; paraspores often present. Characterised by the lateral dichotomous ramuli, and attenuate filaments.

Not uncommon; widely distributed.

6. *C. Deslongchampsii* Chauv. After J. A. Eudes-Deslongchamps, French palæontologist.—Fronds dark brownish purple or blackish red, rigid, densely tufted, 5–12.5 cm. long, slightly attenuate upwards, more or less regularly dichotomously branched, axils not very patent. Branches much divided, either naked throughout or giving off short, simple or forked, lateral ramuli, irregularly distributed, alternate, or secund and crowded. Apices straight and spreading, subulate. Filaments 150–200 μ broad below; articulations about 3 times as long as broad in the lower parts, gradually shorter upwards. Cystoc. in groups, sessile on the branches without involucreal ramuli. Tetrasporang. whorled in the cortical cells.

Not uncommon; widely distributed.

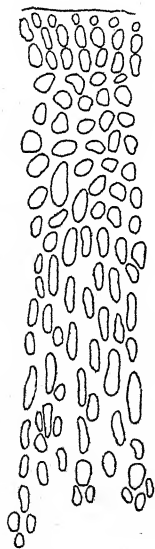


Fig. 237.—*Ceramium circinatum* J. G. Agardh. Portion of the node showing corticating cells spreading in a downward direction ($\times 300$).

7. *C. circinatum* J. G. Agardh (*C. decurrens* Harv.). Lat. *circinare*, to make round.—Frond brick-red or purplish, membranaceous, 15–20 cm. long, gradually attenuate upwards, repeatedly and fairly regularly dichotomous, but scarcely fastigiate, lower divisions distant, gradually closer upwards; simple or forked ramuli scattered sparsely on the branches; apices hooked inwards; filaments 300–500 μ thick below; articulations twice as long as broad in the lower part of the frond, gradually shorter upwards; corticating cells at the nodes in longitudinal rows; cortication extending over more than half each articulation, completely clothing the internode in

the older parts. Cystoc. unknown; tetrasp. in the corticating cells at the nodes, arranged in a whorl. Cortication covering a larger area of the articulation than in *C. diaphanum*.

8. *C. arborescens* J. G. Agardh. Lat. *arborescere*, to become a tree.—Vegetative growth vigorous, recalling *C. rubrum*; the main axes much developed, considerable secondary growth; extremities of the branches usually elongated and curved, uppermost branches often corymbose; cortication present except at the extreme apex. Cystoc. and antherid. rare.

Probably not uncommon; widely distributed.

When characters are not well pronounced the species is with difficulty distinguished from *C. Rosenvingii*.

9. *C. fruticulosum* Kütz. Lat. *fruticula*, a little shrub.—Very variable in size, some individuals as much as 20 cm. diam.; approaching *C. Areschougii* on the one side, *C. rubrum* on the other; branching and cortication variable, the latter sometimes continuous (like *C. rubrum*), sometimes in zones (like *C. Areschougii*), and sometimes intermediate, but developing upwards from the node. Sexual organs rare. Essentially æstival, but sometimes occurring at other times. Deep red in colour, with a tint of dark blue.

Rare; Devon, Dorset and Northumberland.

10. *C. vimineum* J. G. Agardh. Lat. *vimineus*, made of wickerwork.—Thallus very incompletely corticate in the youngest parts; in the older parts cortication distinct at the nodes; articulations 2–3 times as long as broad, lateral branches fertile, elongate and attenuate at each extremity, branching simple. Tetrasporang. in swollen nodes of the ramuli, sometimes single, sometimes arranged in a double row; involucrel ramuli of the cystoc. twice as long as broad.

Devon and Dublin.

11. *C. botryocarpum* Griff. Gr. *botrus*, a bunch of grapes, and *karpon*, fruit.—Filaments purplish red, frequently fading into brownish and greenish yellow; cartilaginous and firm, rather rigid; sharply hooked at the base, gradually attenuate upwards, 7.5–12.5 cm. long, dichotomously branched; branches erect, sometimes corymbose, sometimes unequal, straight, not hooked inwards; main axes and branches usually clothed with short, simple or rarely forked ramuli, subulate or fusiform, attenuate at each extremity, much more slender than the branches; articulations twice as long as broad in the lower parts, about equal to their breadth in the upper, corticate throughout. Cystoc. clusters, without involucrel ramuli, sessile, lateral on the ramuli; tetrasp. in the cortication, several tetrasporang. in each articulation.

Not uncommon; widely distributed.

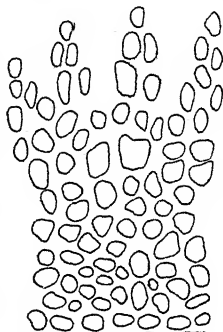


Fig. 238. — *Ceramium fruticulosum* Kütz. Portion of the node showing corticating cells developing in an upward direction ($\times 300$).

12. *C. tenue* J. G. Agardh. Lat. *tenuis*, thin.—Thallus dichotomously branched, ramuli patent, young and old internodes very densely corticate. Cystoc. on branches of the second order, enveloped by involucrel ramuli. Tetrasporang. arranged in a single series, immersed in corticated nodes of simply proliferate ramuli, attenuate at each extremity.

Rare; Orkney.

13. *C. rubrum* C. A. Agardh, var. *pedicellatum* J. G. Agardh. Lat. *rubrum*, red.—Fronds deep clear red, varying through all

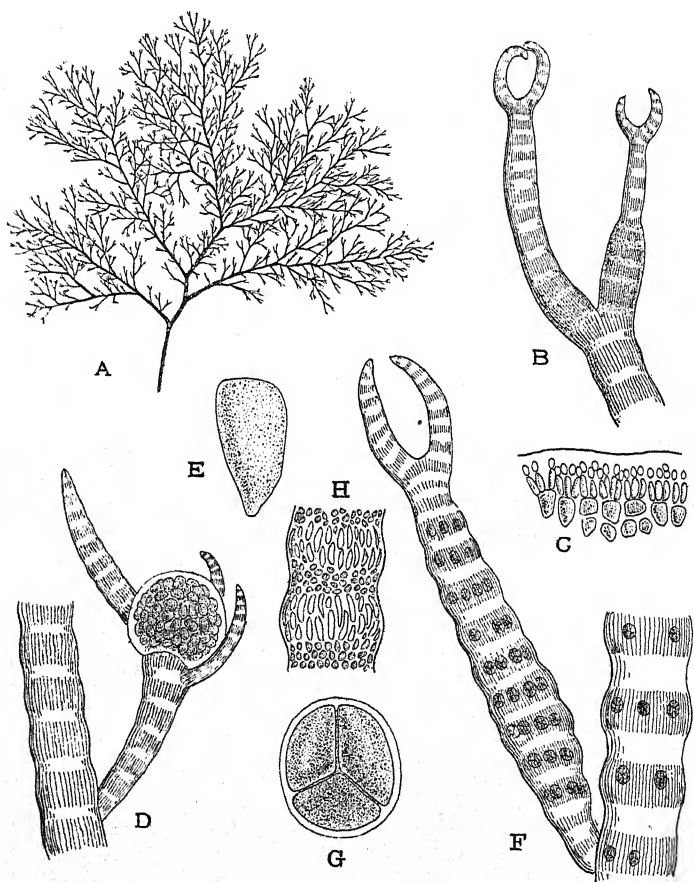


Fig. 239.—*Ceramium rubrum* var. *pedicellatum* J. G. Agardh. A. Plant ($\times \frac{1}{2}$); B. Part of frond with antheridia ($\times 60$); C. Portion of same in section ($\times 300$); D. Part of frond with cystocarp ($\times 33$); E. Carpospore ($\times 300$); F. part of frond with tetraspores ($\times 33$); G. Tetrasporang. ($\times 300$); H. Portion of corticate thallus ($\times 60$).

the shades of red-brown to greenish yellow, membranaceous or cartilaginous, solitary or tufted, 2.5-30 cm. long, gradually attenuate upwards, irregularly dichotomous at long intervals; branches clothed with lateral ramuli, simple, forked or repeatedly dichotomous; axils patent, apices either straight or hooked inwards; filaments 280-560 μ broad; articulations corticate throughout. Cystoc. spherical, sessile on the sides of short lateral ramuli, surrounded by an involucre of short ramuli; tetrasporang. in the corticating cells, several in an articulation, arranged transversely.

Very variable in form; occurring on rocks, stones, and the smaller algæ in rock-pools from high to low-water mark and in deeper water. Common; widely distributed.

var. *fasciculatum* J. G. Agardh.—Internodes of young and adult branches densely corticate, lateral branches fasciculate and corymbose. Not uncommon; S. England and Scotland.

var. *corymbiferum* J. G. Agardh.—Internodes of young and adult branches densely corticate, filaments with sparse lateral branches; ramuli corymbose, dichotomous and fastigate. Not uncommon.

14. *C. secundatum* J. G. Agardh. Lat. *secundatus*, second in rank.—Thallus dichotomous; ramuli at first arising only on the inner side of the main branches at the node, later arising also on the outer side; articulations as much as twice as long as broad. Tetrasporang. at the nodes often forming a transverse double series, later often whorled; involucreal ramuli equal in length to the cystoc.

Rare; Orkney, Cornwall, and Clare.

15. *C. pennatum* Crouan (*C. microcladia* Cocks). Lat. *pennatus*, winged.—Thallus pinnately divided, ramuli branched to some extent on all sides, main axis elongate with lax, alternate, pinnate branches; ramuli few, patent, linear, acuminate, forcipate at the apices; articulations almost equal in length and breadth, completely corticate. Tetrasporang. immersed in the cortex, disposed in whorls.

Rare; widely distributed.

16. *C. Derbesii* Kütz. After A. Derbès, French botanist.—Thallus setaceous, dichotomous, with lateral secondary branches, slightly rough, sub-cartilaginous; ramuli erect-patent, apices forcipate; lower articulations equal in length and breadth, densely corticate. Tetrasporang. in penultimate segments, few in a whorl; cystocarps enveloped by incurved involucreal ramuli.

Devon and Antrim (doubtfully).

17. *C. flabelligerum* J. G. Agardh. Lat. *flabellum*, a fan, and *gero*, I bear.—Fronds dull red, somewhat cartilaginous and rigid, tufted, but not matted together, 5-7.5 cm. long, filaments attenuate upwards; branching irregularly dichotomous, distichous, main divisions with fan-shaded outline, repeatedly

forked; upper branches bearing simple or forked, erect or somewhat patent, lateral ramuli, slightly constricted below, markedly attenuate and acute at the apices; axils of the branches acute, apices generally spreading, sometimes slightly curved, but never hooked inwards; articulations corticate throughout, about twice as long as broad in the lower parts, equal in length and breadth above, bearing on the outer edge, at each node, a minute thorn-like structure, 3 cells long. Cystoc. several together, lateral on the upper branches, surrounded by several patent, subulate ramuli; tetrasporang. occupying the whole depth of an articulation, in whorls.

Epiphytic on the smaller algæ between the tide marks. Not uncommon; widely distributed.

18. *C. echionotum* J. G. Agardh. Gr. *echis*, an adder, and *noton*, a back.—Fronds purplish red, harsh and rigid to the touch. Densely tufted, 7.5–15 cm. long, of almost equal diam. throughout or slightly attenuate upwards, many times dichotomous, often bearing lateral, repeatedly forked, fastigate branches; axils patent throughout; apices more or less strongly hooked inwards; articulations corticate at the nodes, 3–4 times as long as broad in the lower parts, gradually shorter upwards, very short in the ultimate branches, bearing throughout irregularly placed unicellular, brittle, colourless, acicular spines, on each band of corticating cells. Cystoc. usually in pairs near the apices of the frond or of lateral branchlets, often in the ultimate bifurcation, surrounded by an involucre of incurved ramuli; tetrasporang. confined to the outer edge of the filament, one or rarely two in each articulation.

On rocks and stones between the tide marks; also in rock pools epiphytic on other algæ. Not uncommon; S. England, N. and W. Ireland.

var. *transcurrens* Batt. (*Acanthoceros transcurrens* Kütz.).—Lower articulations as long as broad or rather shorter, upper articulations twice as long as broad. Devon and Dorset.

19. *C. ciliatum* Ducluz. Lat. *cilium*, an eyelash.—Fronds purplish red, membranaceous and rigid, forming dense tufts, 7.5–15 cm. long; filaments of nearly equal diam. throughout, repeatedly dichotomous, sometimes bearing fastigate lateral branchlets; apices strongly hooked inwards, axils rather patent; articulations 3–4 times as long as broad in the lower parts, gradually shorter upwards, corticate at the nodes, each articulation bearing a whorl of subulate, acicular spines, 3 cells long, the lowest cell being much larger than the others. Cystoc. roundish, lateral, nearly sessile, usually accompanied by 3 or 4 incurved involucreal ramuli; tetrasporang. arranged in a whorl in the corticating cells, alternating with the spines.

On rocks and stones, in rock pools or between the tide marks; also attached to corallines and other algæ.

Distinguished from *C. echinotum* by the more regularly whorled arrangement of the spines, and by the fact that the latter are formed of 3 cells in this species and are unicellular in *C. echinotum*.

20. *C. acanthonotum* Carm. Gr. *akantha*, a thorn, and *noton*, a back.—Fronds dark purple, rigid, densely tufted, matted when old, 5–15 cm. long, of equal diam. throughout, many times dichotomous, more or less furnished with lateral dichotomous branchlets, often repeatedly divided; axils patent throughout, apices strongly inrolled; articulations corticate at the nodes, several times longer than broad in the lower parts, gradually shorter upwards; each articulation bearing a 3-celled broadly subulate, acute, pigmented spine on its outer side. Cystoc. globose, lateral, subtended by a single strongly incurved ramulus; tetrasporang. in whorls, large, occupying almost the whole length of the corticating layer.

On exposed rocks near low-water mark, and on the smaller algæ. Common; widely distributed.

20. MICROCLADIA Grev.

(Gr. *mikros*, small, and *klados*, a branch.)

Filiform, compressed, distichously branched, articulations scarcely visible; axis monosiphonous, surrounded by a pericentral zone of large cells and an outer layer of small cells. Cystoc. sub-globose or irregular, surrounded by involueral ramuli; tetrasporang. immersed in the ramuli near their apices, tetrahedral (or cruciate?), borne on separate individuals.

M. glandulosa Grev. Lat. *glandulosus*, full of kernels.—Fronds deep red, darker towards the base, cartilaginous and membranaceous, tufted, 2.5–10 cm. long, compressed, branched from the base, alternate or irregularly dichotomous, forming roundish fastigiate tufts; branches distichous, axils rounded, patent; dichotomous or irregularly divided ramuli on the upper parts; apices of the ramuli sometimes bifid and hooked inwards, otherwise subulate; articulations absent or scarcely visible owing to the presence of corticating cells. Cystoc. subglobose or lobed, sessile on the outer margin of the ramuli, surrounded by 2 or 3 short involueral ramuli; tetrasporang. immersed in the ramuli, near their apices, usually arranged in a longitudinal series on the outer edge of the branches.

On rocks, algæ or sponges, near extreme low-water mark or at greater depth. Rare; widely distributed.

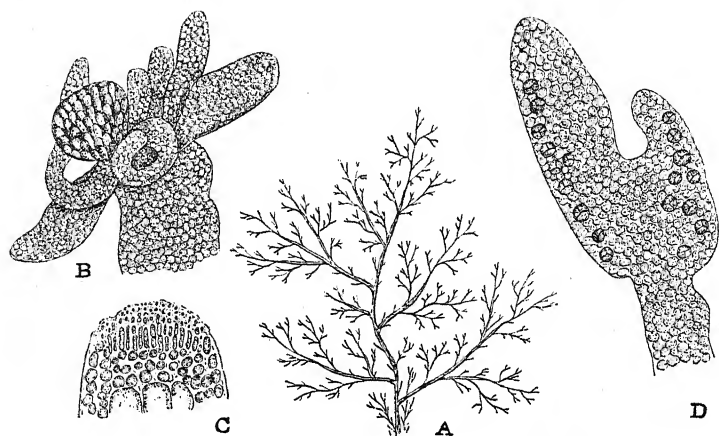


Fig. 240.—*Microcladia glandulosa* Grev. A. Plant ($\times \frac{3}{8}$); B. Apex of frond with cystocarp ($\times 60$); C. Trans. sect. of thallus with antheridia ($\times 200$); D. Apex of frond showing tetrasp. ($\times 60$).

Order V.—GIGARTINALES

Auxiliary cells present before fertilisation; procarps present.

Family I.—GIGARTINACEÆ

Thallus growth by means of many apical cells. Carpogonial branch and auxiliary organ united to a procarp. After the auxiliary fusion the auxiliary cell develops long filaments which grow inwards, ramify and by degrees produce carpospores. Tetrasporang. cruciately divided.

1. **CHONDRUS** Stackh.

(Gr. *chondros*, cartilage.)

Thallus flat, fleshy, cartilaginous, dichotomously branched, composed of an internal layer of slender, cylindrical, anastomosing filaments passing horizontally outwards and dividing dichotomously into short moniliform filaments. Antherid. in superficial spots; tetrasp. cruciate, densely aggregated, forming spots just below the surface; conceptacles immersed in the frond.

C. crispus Lyngb. Lat. *crispus*, curled.—Fronds reddish purple, 7.5–15 cm. high, stipitate, cartilaginous, dichotomous, fastigate, flat, segments wedge-shaped, very variable in breadth; apices truncate or cloven, axils obtuse. Cystoc. sunk in the frond, usually projecting on one side.

On rocky shores, from three-quarters tide-level to low-water mark and beyond it. Common; widely distributed.

var. **virens** Turn.—Sub-membranaceous; branches dilated upwards, extreme segments long and acuminate. Not uncommon; Cornwall, Devon and Dorset.

var. **stellatus** Turn., *pro parte*.—Sub-membranaceous; branches dilated upwards, divided into numerous clustered lacinia at their apices. Very common on most parts of the coast.

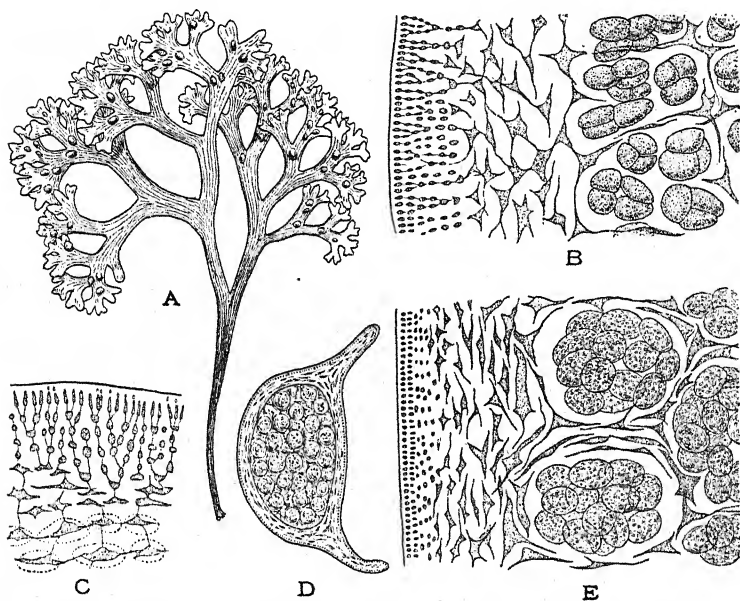


Fig. 241.—*Chondrus crispus* Lyngb. A. plant ($\times \frac{1}{2}$); B. Trans. sect. of thallus with tetraspores ($\times 220$); C. Trans. sect. of antheridial thallus ($\times 280$); D. Trans. sect. of cystocarp ($\times 10$); E. portion of same ($\times 220$).

var. **æqualis** Turn., *pro parte*.—Cartilaginous, thick; branches equal and linear, extreme segments obtuse. Common; widely distributed.

var. **filiformis** Turn.—Cartilaginous, sub-cylindrical; branches nearly linear, apices long and acuminate. Not uncommon; S. England.

var. **patens** Turn.—Sub-cartilaginous, channelled on one side, dichotomous; branches patent. Not uncommon; S. England and Channel Islands.

var. **sarniensis** Turn. Lat. *Sarnia*, Guernsey.—Between coriaceous and cartilaginous; branches slightly channelled on

one side, apices rounded. Rather rare; S. England and Channel Islands.

var. *lacerus* Turn.—Cartilaginous, compressed; apices very narrow, elongated, branched. Rather rare; widely distributed.

var. *planus* Turn.—Sub-coriaceous, flat, wide, branches linear, apices acute. Not uncommon; widely distributed.

This species is extremely variable in form under different environmental conditions. When exposed to the full force of the open sea the fronds are ligulate and narrow; under estuarine conditions the plant is much larger, lobed, fringed and parsley-like in form. This plant is the Carragheen, or Irish Moss, used for making soups, jellies, size and other things needing gelatine in their preparation. The name comes from Carragheen, near Waterford, Ireland, where *Chondrus crispus* abounds. At one time it was a fashionable remedy in cases of consumption, and its collection and preparation for the market afforded a small revenue to the peasants on the west coast of Ireland.

2. GIGARTINA Stackh.

(Gr. *gigarton*, a grape stone.)

Fronds fleshy, cartilaginous, filiform, compressed or flat, irregularly divided, composed of an internal layer of slender, longitudinal anastomosing filaments, passing outwards horizontally and dividing dichotomously into short moniliform filaments forming the assimilative layer. Antherid. in superficial spots; tetrasp. cruciate, aggregated into sori, forming spots below the surface; cystoc. external, borne directly on the surface of the frond or on short papillæ.

Key.

- | | |
|-----------------------------------------|---------------------------|
| 1. Frond cylindrical | <i>G. acicularis</i> (2). |
| Frond more or less flattened | 2. |
| 2. Frond channelled | <i>G. stellata</i> (4). |
| Frond flat | 3. |
| 3. Branching irregularly pinnate | <i>G. Teedii</i> (1). |
| Branching irregularly dichotomous | <i>G. pistillata</i> (3). |

1. *G. Teedii* Lamour. After Mr. Teede, collector.—Fronds dull brownish red, cartilaginous, membranaceous, 7.5–15 cm. long, flaccid, flat, linear, acuminate, repeatedly pinnate; pinnæ opposite or alternate, horizontally patent, distichous, set with horizontal, spine-like ramuli; cystoc. globose, sessile on the ramuli (not recorded from Britain).

On rocks at the extreme limit of low water. Very rare; Devon and Jersey.

2. *G. acicularis* Lamour. Lat. *acicula*, a small pin.—Fronds dull purple-red, in tufts, 4–10 cm. long, cartilaginous, cylindrical, filiform, irregularly branched, sometimes almost pinnate, branches divaricate, curved; ramuli few, very patent or recurved, subulate, often secund. Cystoc. spherical, sessile on the branches.

On rocks near low-water mark. Very rare; S. England, Ireland and Channel Islands.

3. *G. pistillata* Stackh. Lat. *pisillum*, pestle.—Fronds dull purple or brownish red. Densely tufted, 5-15 cm. high, com-

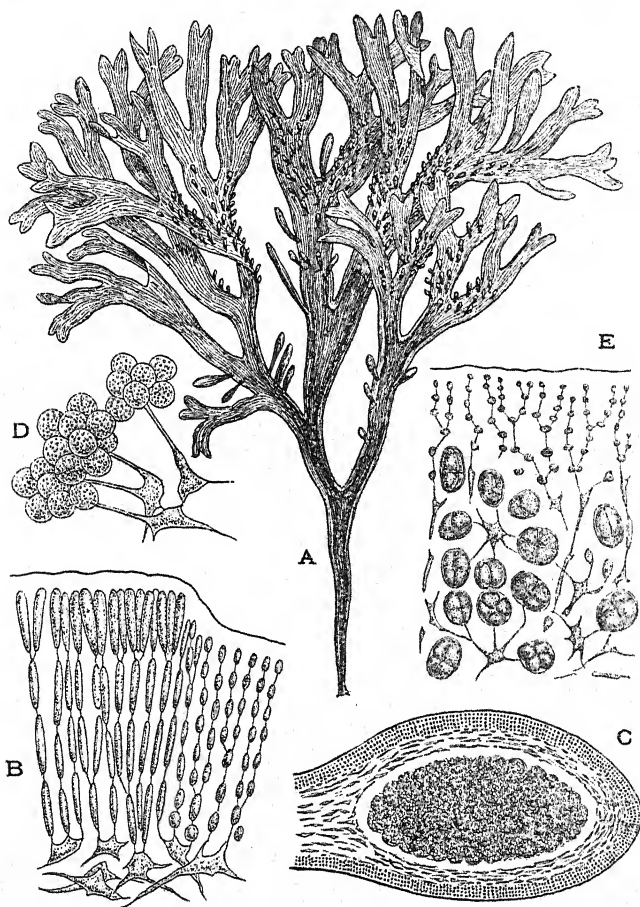


Fig. 242.—*Gigartina stellata* Batt. A. plant ($\times \frac{3}{8}$); B. Trans. sect. of antheridial thallus ($\times 400$); C. Trans. sect. of cystocarp ($\times 26$); D. Portion of same with carpospores ($\times 400$); E. Trans. sect. of tetrasporic thallus ($\times 300$).

pressed, rising with an undivided frond to a height of 2.5 or 5 cm., then branching dichotomously in a fan-like manner, compressed; branches repeatedly forked with wide rounded axils, naked, or pinnated with short horizontal ramuli; apices

acute. Tetrasp. in immersed sori forming distortions in the branches; cystoc. solitary or in pairs, spherical, sessile on the ramuli.

Very rare; Cornwall and the Channel Islands.

4. *G. stellata* Batt. (*Gigartina mamillosa* J. G. Agardh). Lat. *stellatus*, set with stars.—Fronds tufted, 10–20 cm. high, cartilaginous, dichotomous, fastigiate, upper segments wedge-shaped, branches channelled by the introflexion of the margin; surface of the upper parts thickly set with erect, partly cylindrical, fleshy excrescences, bearing cystoc. at their apices. Excrescences may be absent in young or sterile specimens, when the plant resembles *Chondrus crispus*, but is easily distinguishable by its channelled frond.

On rocks near low-water mark. Common; widely distributed.

var. *acuta* Good. & Woodw. (incl. *f. linearis* Turn.).—Apices acute. Not uncommon; S. England and Northumberland.

var. *prolifera* Turn. (incl. *f. stellata* Turn.).—Frond proliferous. Not uncommon; Cornwall and Kent.

var. *incurvata* Turn.—Frond nearly linear with rounded apices and incurved cystoc. Rather rare; S. England.

G. stellata has the same officinal properties as *Chondrus crispus*, and is on some shores collected with that species and dried as Carrageen, or Irish Moss.

3. PHYLLOPHORA Grev.

(Gr. *phyllon*, a leaf, and *phoreo*, I bear.)

Fronds stipitate, expanding upwards into a rigid or membranaceous, flat lamina, simple or divided, proliferous from the margin or from the basal disc, composed internally of oblong polygonal cells bounded by a cortical layer of minute, vertically seriate, assimilative cells. Antherid. in small cavities in the thallus; tetrasp. cruciate, arranged in moniliform filaments packed together in wart-like excrescences; cystoc. external, globose, pedicellate or sessile. In some species secondary tissue has been observed near the axils of the branches and also at the base of the frond and on the surface of the attachment organ.

Key.

- | | |
|---------------------------------------------------------------------------------|------------------------------|
| 1. Plant attached by a fleshy disc, 2.5 cm. or more diam. | <i>P. palmettoides</i> (3). |
| Plant without a widely spreading, fleshy attachment disc | 2. |
| 2. Plant 1–1.5 cm. high | <i>P. Traillii</i> (4). |
| Plant more than 1.5 cm. high | 3. |
| 3. Plant brownish or purplish red, branches expanded in a fan-like manner | <i>P. membranifolia</i> (5). |
| Plant red, branches proliferous from their apices | 4. |

4. Very shortly stipitate, thallus gradually expanding *P. epiphylla* (1).
 Stipitate, filiform below, branched above, the branches gradually becoming compressed and expanded *P. Brodiaei* (2).

1. ***P. epiphylla*** Batt. (*P. rubens* Grev.). Gr. *epi*, upon, and *phullon*, a leaf.—Fronds tufted, membranaceous, 7.5–25 cm. long, shortly stipitate, the stipe gradually expanding into the flattened attenuated base of a linear wedge-shaped, simple or dichotomous lamina, each segment linear and very obtuse, often

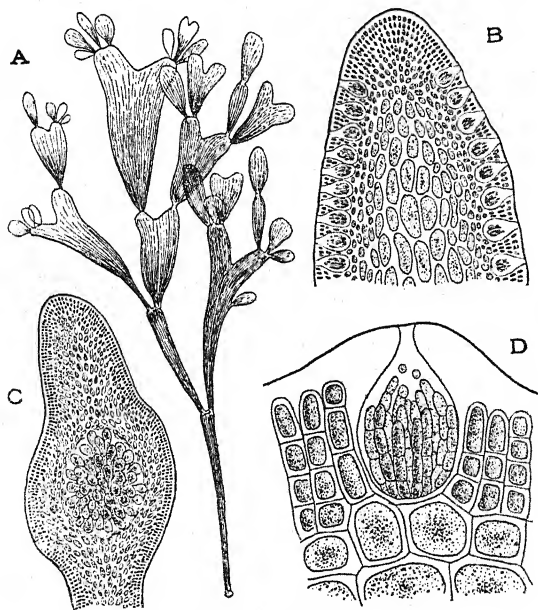


Fig. 243.—*Phyllophora Brodiaei* C. A. Agardh. A. plant ($\times \frac{2}{3}$); B. Trans. sect. of antheridial thallus ($\times 130$); C. *P. membranifolia* J. G. Agardh. trans. sect. through cystocarp ($\times 55$); D. Trans. sect. of antheridial thallus ($\times 660$).

proliferous from the apex. Cystoc. very shortly stalked on the surface of the thallus, spherical, wrinkled on the outside.

On the shelving sides of rocky tide-pools near low-water mark, and lower on rocks, stones and nullipores. Frequently partly covered with coralline algæ and small shells. Not uncommon; widely distributed.

2. ***P. Brodiaei*** C. A. Agardh. After J. Brodie, Scottish collector.—Fronds purplish red or rose-red, 5–20 cm. long, stipe cylindrical at the base, compressed upwards, branched, the branches expanding into oblong or wedge-shaped, simple or

dichotomously branched, membranaceous laminae, often proliferous at the summit. Cystoc. globose, sessile on the laminae, bearing tetrasp., not carposp.

Rather rare; widely distributed.

var. *angustissima* C. A. Agardh.—More elongated and narrower than the type. Very rare; Orkney Islands.

3. *P. palmettoides* J. G. Agardh. From *Rhodymenia palmetta*, and Gr. *eidos*, like.—Fronds rosy red, membranous but rather rigid, attached by a widely spreading fleshy disc, 2.5 cm. or more diam.; many from the same disc, scattered, 5–10 cm. long, rising with a filiform stem below; later compressed, ending in cuneate or narrow-obovate, obtuse lamina, simple or dichotomously divided, often proliferous from the apex. Tetrasp. in oval sori in the centre of the lamina.

Rare; S. England, Ireland, Isle of Man and Channel Islands.

4. *P. Traillii* Holm. & Batt. After Professor G. W. Traill, Scottish botanist.—Fronds seldom more than 1.5 cm. high; stipitate at the base, filiform, simple or branched, expanding into oblong or wedge-shaped laminae either simple or slightly forked, sometimes more or less irregular in outline, usually fringed with minute almost colourless branchlets. Cystoc. immersed in marginal branchlets.

On shady rocks near low-water mark, and under projecting ledges of rock in caves. Probably not uncommon; widely distributed.

Distinguishable from *P. palmettoides* by the absence of the widely expanded radical disc.

5. *P. membranifolia* J. G. Agardh. Lat. *membrana*, skin, and *folium*, leaf.—Fronds brownish or purple-red, tufted, 7.5–30 cm. high; stipe cylindrical, filiform, branched, the branches expanding into broadly wedge-shaped bifid or dichotomous laminae; in old specimens, besides the terminal frondlet, the branches give off numerous lateral ones of a smaller size, bifid and narrowly wedge-shaped; apices fastigate. Cystoc. ovoid, stipitate, rising from the branches or laminae; tetrasp. in broad, dark-coloured, convex patches in the centre of the laminae.

Common; widely distributed.

4. *STENOGRAMMA* Harv.

(Gr. *stenos*, narrow, and *gramme*, a line.)

Frond membranaceous, flattened, dichotomously branched, sometimes proliferous from the upper parts, composed of a central mass of large colourless cells, becoming smaller near the mid-rib and an outer zone of small assimilative cells. Cystoc. in the flattened branches directly over the mid-rib; antherid.

in groups on the upper parts of the frond ; tetrasp. in external hemispherical nemathecia, cruciate.

S. interruptum Mont.—Frond pinkish red, cartilaginous, stipitate, more or less deeply lacinate, fan-shaped ; laciniaë repeatedly dichotomous, apices obtuse, margin usually flat and

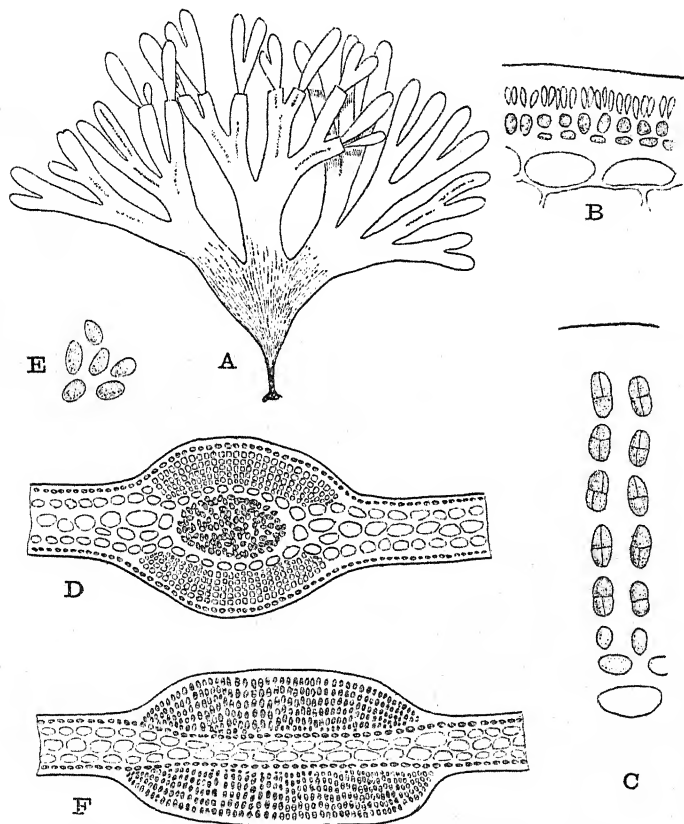


Fig. 244.—*Stenogramma interruptum* Mont. A. Plant showing signs of linear fructification in the upper parts ($\times \frac{3}{4}$); B. Trans. sect. of antheridial thallus ($\times 300$); C. Portion of tetrasporic pustule ($\times 300$); D. Trans. sect. of thallus in cystocarpic region ($\times 150$); E. carpospores ($\times 300$); F. Trans. sect. of tetrasporic thallus showing tetrasporang. in chains ($\times 150$).

entire, sometimes bearing small, curled, lobed processes ; fertile fronds traversed by mid-rib on which cystoc. are borne.

Very rare ; S.W. England and Ireland.

5. **GYMNOGONGRUS** Martius(Gr. *gymnos*, naked, and *gongros*, an excrescence.)

Fronds coriaceous, dark red or purple, terete, compressed or flat, dichotomous, consisting of a central core of rounded or angular colourless cells, and a peripheral layer of small closely packed assimilative cells, arranged in rows perpendicular to the surface. Cystoc. immersed in the swollen frond; tetrasp. cruciate.

Key.

- | | |
|------------------------------|----------------------------|
| 1. Frond channelled | <i>G. patens</i> (3). |
| Frond flat | 2. |
| 2. Thallus cylindrical | <i>G. Griffithsia</i> (1). |
| Thallus flattened | <i>G. norvegicus</i> (2). |

1. ***G. Griffithsia*** Martius. After Mrs. Griffiths, British algologist.—Frond brown-red to blackish purple, filiform, flexuous, cartilaginous, stipitate, many times dichotomous, attached by a disc, spreading on the surface of the rock, densely tufted, 2.5–7.5 cm. high, apices fastigate, axils of the branches rounded, terete throughout, except the apices, which are sometimes more or less compressed.

On submarine rocks near low-water mark. Rather rare; widely distributed.

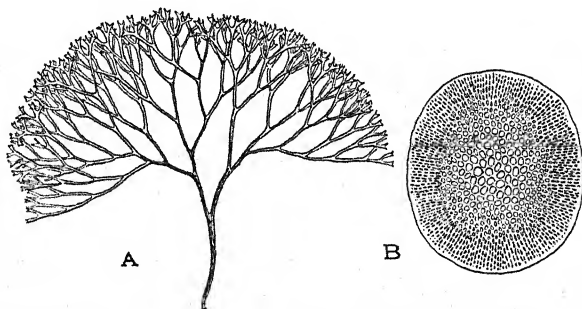


Fig. 245.—*Gymnogongrus Griffithsia* Martius. A. Plant ($\times \frac{2}{3}$); B. Trans. sect. of thallus ($\times 60$).

2. ***G. norvegicus*** J. G. Agardh. Mod. Lat. *norvegicus*, Norwegian.—Fronds linear, dichotomous, flat, axils patent, apices rounded, 5–10 cm. high, stipitate, or branched almost from the base, attached by a small disc. Cystoc. immersed in the swollen frond.

On rocks near low-water mark. Rather rare; widely distributed.

Distinguishable from *Chondrus crispus* in the field, by its redder colour and more delicate thallus.

3. *G. patens* J. G. Agardh. Lat. *patens*, exposed.—Fronds purple, in erect tufts, 10–15 cm. long, attached by an expanded disc, terete below, flattened above, canaliculate; upper segments membranaceous, branching dichotomous, fastigate, segments linear, apices cuneate, truncate.

Very rare; Cornwall.

Miss B. D. Gregory, M.Sc., permits me to quote her unpublished work, which has established the fact that the pustule, formerly referred to the genus *Actinococcus* Kütz., and believed to be parasitic on *Gymnogongrus Griffithsiae* Mart., is actually the tetrasporic nemathecium of the *Gymnogongrus*. At present it is not possible to make any statement with regard to *Actinococcus pelliciformis* Schm., which was formerly regarded as a parasite on *Gymnogongrus norvegicus* J. G. Agardh.

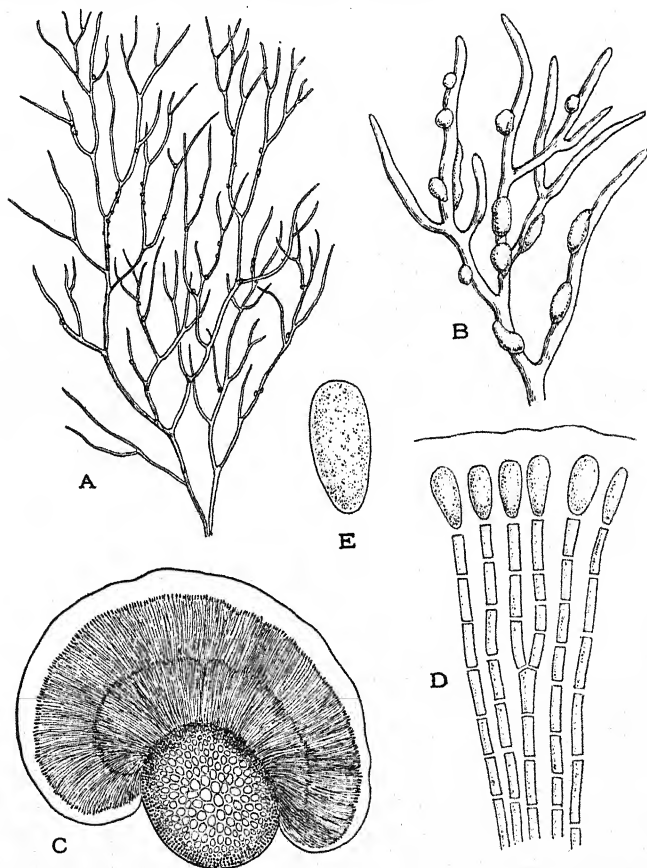


Fig. 246.—*Ahnfeltia plicata* Fries. A. Plant with pustules ($\times 2$); B. Portion of same ($\times 2$); C. Trans. sect. in region of pustule ($\times 80$); D. Margin of pustule with monospores ($\times 600$); E. single monospore ($\times 1200$).

6. **AHNFELTIA** Fries

(After Nils Otto Ahnfelt, Swedish botanist.)

Frond horny, subterete, dichotomous or irregularly branched, formed of a central core of densely packed elongated cells and a peripheral layer of closely packed small assimilative cells.

A. plicata Fries (*Gymnogongrus plicatus* Kütz.). Lat. *plicatus*, folded.—Fronds dark purple, almost black, horny, cylindrical, filiform, very irregularly branched, entangled; branches ditrichotomous with lateral, often secund branches, axils obtuse, apices blunt.

Very common; widely distributed.

Distinguishable from all other Floridæ by its extremely wiry, rigid substance.

Recent work by Miss B. D. Gregory, M.Sc. has shown that the pustule formerly attributed to *Sterrocolax decipiens* Schmitz and regarded as parasitic on *Ahnfeltia plicata* Fries is actually a part of the *Ahnfeltia* thallus. The pustule bears monospores, of which the exact nature is still obscure.

7. **COLACOLEPIS** Schmitz(Gr. *kolaks*, a parasite, and *lepis*, a scale.)

Thallus forming a minute tubercle on the host plant, parasitic. Tetrasp. in chains, cruciate, sometimes undivided.

C. incrustans Schmitz.—Parasitic on the fronds of *Phyllophora epiphylla*, probably to be found wherever the host occurs.

8. **CALLOPHYLLIS** Kütz.(Gr. *kallos*, beauty, and *phyllon*, a leaf.)

Thallus membranaceous, flattened, dichotomous or palmate; mid-rib absent, consisting internally of large cells interspersed with small ones, the whole bounded by a layer of short moniliform filaments, perpendicular to the surface. Cystoc. in the margin of the frond; tetrasp. cruciate, in a superficial layer.

Key.

Apices sub-erenate *C. flabellata*.
Apices obtuse *C. laciniata*.

C. laciniata Kütz. (*Rhodymenia laciniata* Grev.). Lat. *laciniatus*, in small divisions.—Frond thickish, sub-cartilaginous, opaque, bright red, stipitate, more or less palmate, cleft into numerous, broad, wedge-shaped segments, again divided in a sub-dichotomous manner, apices obtuse; when in fruit margin

curled and fringed with minute proliferations in which the cystoc. are formed; mid-rib absent.

On rocks and stones and on *Laminaria*, rarely within the tide-marks. Not uncommon; widely distributed.

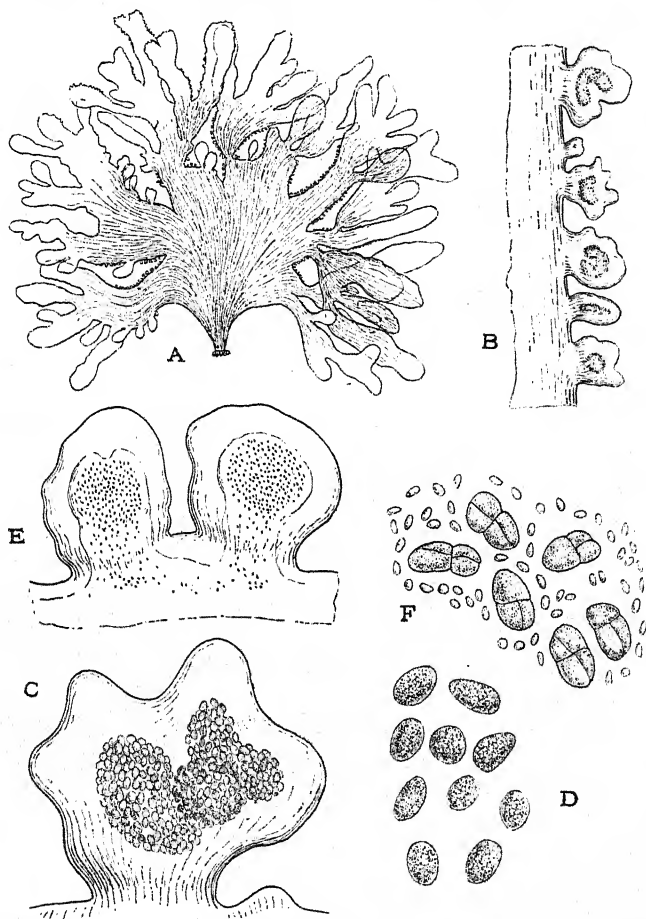


Fig. 247.—*Callophyllis laciniata* Kütz. A. Plant ($\times \frac{2}{3}$); B. Margin of frond with cystocarps ($\times 12$); C. Portion of the same ($\times 60$); D. Carpospores ($\times 300$); E. Margin of frond with tetrasporangia ($\times 300$); F. Portion of same, surface view ($\times 300$).

C. flabellata Crouan. Lat. *flabellum*, a fan.—Frond stipitate, orbicular, attenuate at the base, dichotomous or sub-palmate, apices sub-crenate. Cystoc. in marginal proliferations as in *C. laciniata*; tetrasp. on the upper part of the frond.

On rocks near river mouths. Very rare; Cornwall, Co. Clare.

9. CALLOCOLAX Schmitz

(Gr. *kallos*, beauty, and *kolaks*, a parasite.)

Parasitic, situated on the edge or the surface of the frond of the host, bearing cystoc. or tetrasp. similar to those of the host. Occurring solitary or in groups, irregular in shape, simple, lobed or palmate, lower portion penetrating tissue of the host.

C. neglectus Schmitz.—Fronds minute, solitary or gregarious, parasitic on *Callophyllis laciniata*, situated on the edge or surface of the frond, bilobed, palmate or irregular, 2-4 mm. high, about

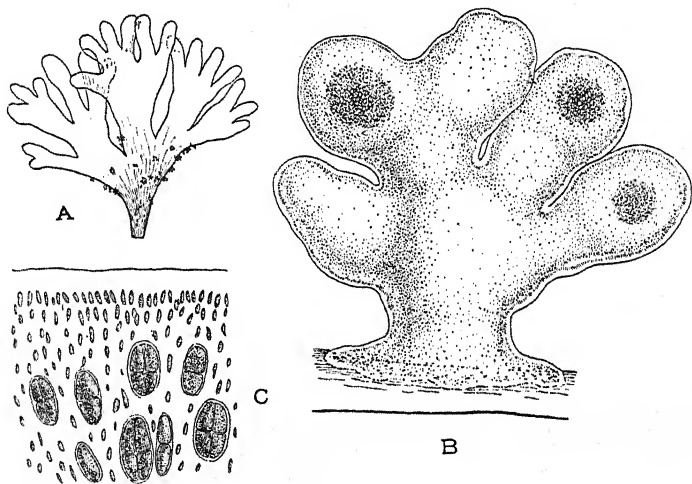


Fig. 248.—*Callocolax neglectus* Schmitz. A. Colonies on *Callophyllis laciniata* ($\times 1$); B. Single cystocarpic thallus ($\times 40$); C. Trans. sect. of tetrasporic thallus ($\times 300$).

as long as broad. Tetrasp. cruciate, 18-20 diam.; cystoc. like those of *Callophyllis*, large, occupying almost the entire frond, which then assumes a nearly globular shape; antherid. unknown.

Probably not uncommon where the host plant occurs.

10. CALLYMENIA J. G. Agardh

(Gr. *kallos*, beauty, and *humen*, a membrane.)

Thallus expanded, mid-rib absent, membranaceous, formed internally of three layers: an inner layer of interweaving elongated filaments, bounded on each side by a layer of angular cells, followed by a dense layer of minute assimilative cells.

Cystoc. sunk in the thallus, forming swollen spots; tetrasp. on separate plants, scattered.

Key.

Stipe 2-15 mm. long, thallus 1-5 cm. broad *C. microphylla*.

Stipe 0.75-1.25 cm. long, thallus 2.5-20 cm. or more broad *C. reniformis*.

C. reniformis J. G. Agardh. Lat. *renes*, kidneys, and *forma*, shape.—Stipitate, stipe cylindrical, 0.70-1.25 cm. long, suddenly expanding into a roundish, sub-simple or irregularly cleft, somewhat lobed frond, membranaceous, blood-red, simple or producing at the margin secondary fronds resembling the primary one in form and substance, varying in breadth from 2.5-20 or even 35 cm. Tetrasp. minute, among the surface cells.

In deep shady pools, at extreme low-water mark. Rare; widely distributed.

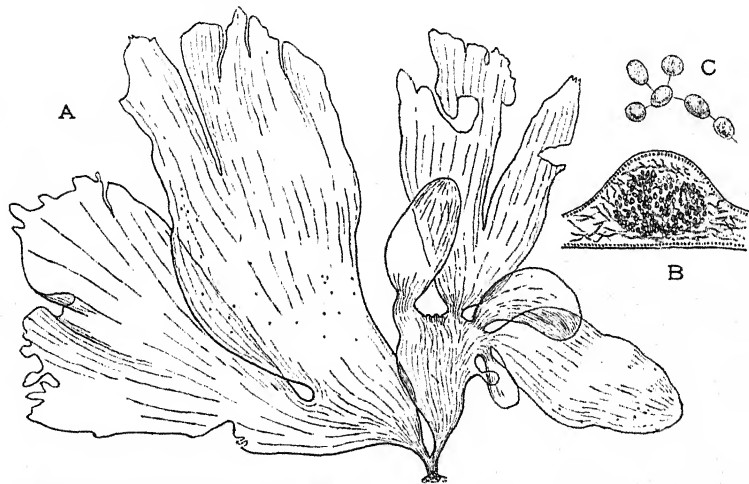


Fig. 249.—*Callymenia reniformis* J. G. Agardh. A. Plant ($\times \frac{2}{3}$); B. Trans. sect. of cystocarp ($\times 60$); C. carpospores ($\times 300$).

var. ***undulata*** J. G. Agardh.—Frond ovate, rotund, sessile and reniform at the base; margin wide and undulate, entire or slightly lobed. Very rare; S.W. England.

var. ***Ferrarii*** J. G. Agardh.—More slender than the type, attenuate at the base into a well-defined stipe; margin sub-laciniate, proliferated into obovate lobes. Rare; Devon, Orkneys and Channel Islands.

2. ***C. microphylla*** J. G. Agardh (*Meredithia microphylla* J. G. Agardh). Gr. *mikros*, small, and *phyllon*, a leaf.—Thallus dark red when young, purple when old, membranaceous, stipitate, 1.0 cm. high; stipe cylindrical, simple or branched, 2-15 mm.

long, 1-2 mm. thick; leafy expansion simple, roundish, egg-shaped or obliquely cordate, 1-3 cm. long, with smooth or irregular edge, frequently proliferated. Cystoc. about 1 mm. broad.

Very rare; S. England and Carnarvon.

Family II.—RHODOPHYLLIDACEÆ

Growth by an apical cell; carpogonial branch and auxiliary organ united to a procarp; auxiliary cell formed from a uninucleate vegetative cell in the inner cortex; cystoc. without ostiole; tetrasporang. zonate.

1. CYSTOCLONIUM Kütz.

(Gr. *kustis*, a bladder, and *klon*, a small branch.)

Fronds succulent, terete, cartilaginous, decompoundly branched, composed of three cell-layers: an innermost core of loosely interwoven filaments formed of elongated cells, surrounded by a zone of large rounded cells, and a peripheral layer of small closely packed assimilative cells. Antherid. in spots on the upper part of the fronds, among unchanged cortical cells; cystoc. immersed in the frond, usually prominent on one side, with a single ostiole; tetrasp. zonate, scattered in the outer layer.

C. purpureum Batt. (*Cystoclonium purpurascens* Kütz.).—Fronds dull purplish pink, cylindrical, 15-60 cm. long, terete, somewhat attenuate at base and apex, excessively and irregularly branched, bushy, soft; branches alternate, elongate, densely clothed with alternately decompound branchlets attenuate at base and apex. Cystoc. numerous, large, forming nodose swellings in the branches.

On rocks and stones within the tide-marks. Common; widely distributed.

Emitting an aromatic odour, rather suggestive of *Allium*, after having been gathered a short time.

var. **cirrhusa** J. G. Agardh.—The branches drawn out into elongated twisting tendrils. Rather rare; S. England, Berwick and Dublin.

2. CATENELLA Grev.

(Lat. *catena*, a chain.)

Frond dull purple, membranaceous, filiform, constricted at intervals; axis composed of a lax network of anastomosing longitudinal filaments, the periphery formed of densely compacted dichotomous, moniliform filaments at right angles to the surface. Cystoc. elongated, sessile on the branches with a terminal ostiole;

antherid. on swollen branchlets, formed from the surface cells;
 tetrasp. on separate plants, zonate, formed in the peripheral
 cells.

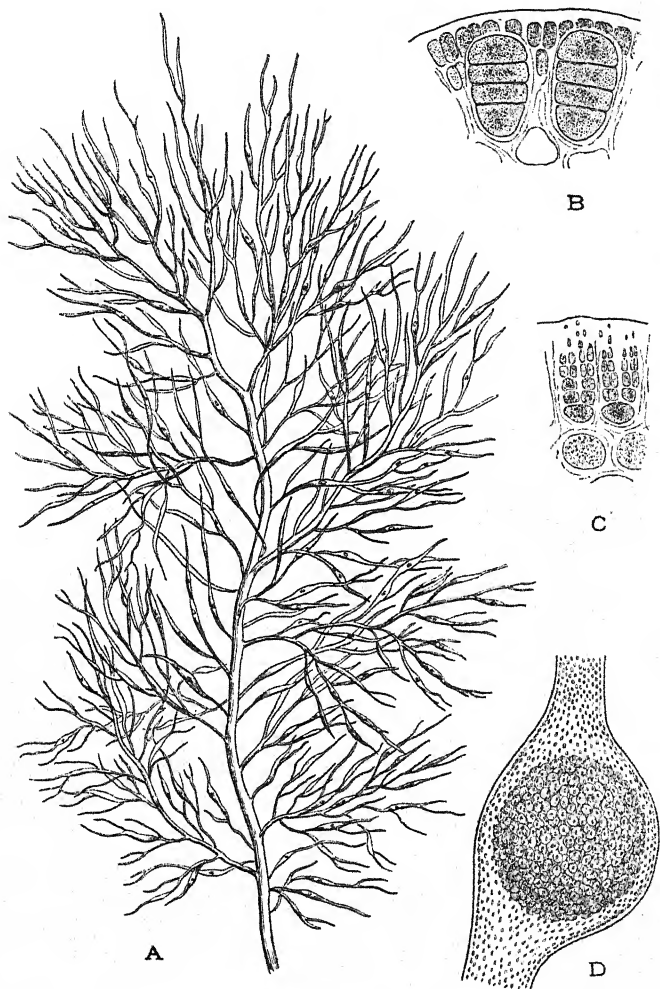


Fig. 250.—*Cystoclonium purpureum* Batt. A. Plant ($\times \frac{3}{4}$); B. Trans. sect. of same with tetraspores ($\times 180$); C. Trans. sect. of thallus with antheridia ($\times 380$); D. Trans. sect. of cystocarp ($\times 30$).

C. repens Batt. (*Catenella opuntia* Grev.). Lat. *repens*, creeping.—Fronds arising from a mass of creeping fibres,

irregularly branched, resembling *Opuntia* in general form, about 3 cm. high, patches 5 or more cm. diam. ; frond constricted at intervals into a string of oblong or lanceolate segments.

Not uncommon on the rocky shores of the British Islands, fruiting in protected places.

Distinguishable from a small plant of *Chylocladia articulata* by its more purple colour, wide angle of divergence of the branches and oblong or lanceolate segments, in addition to the difference in internal structure.

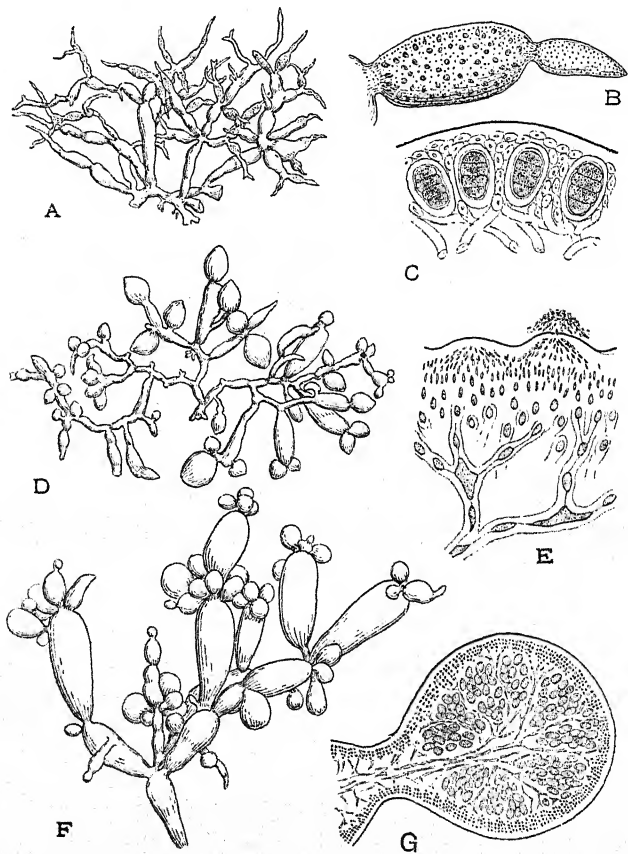


Fig. 251.—*Catenella repens* Batt. A. Tetrasporic plant ($\times 6$); B. Portion of the same ($\times 33$); C. Section of the same ($\times 100$); D. antheridial plant ($\times 6$); E. Trans. sect. of same ($\times 300$); F. Cystocarpic plant ($\times 6$); G. Section of the same ($\times 60$).

3. **EUTHORA** J. G. Agardh(Gr. *eu*, well, and *thore*, sperm.)

Frond membranaceous, flat, sub-dichotomously pinnate, interior consisting of large, elongated, angular cells, bounded

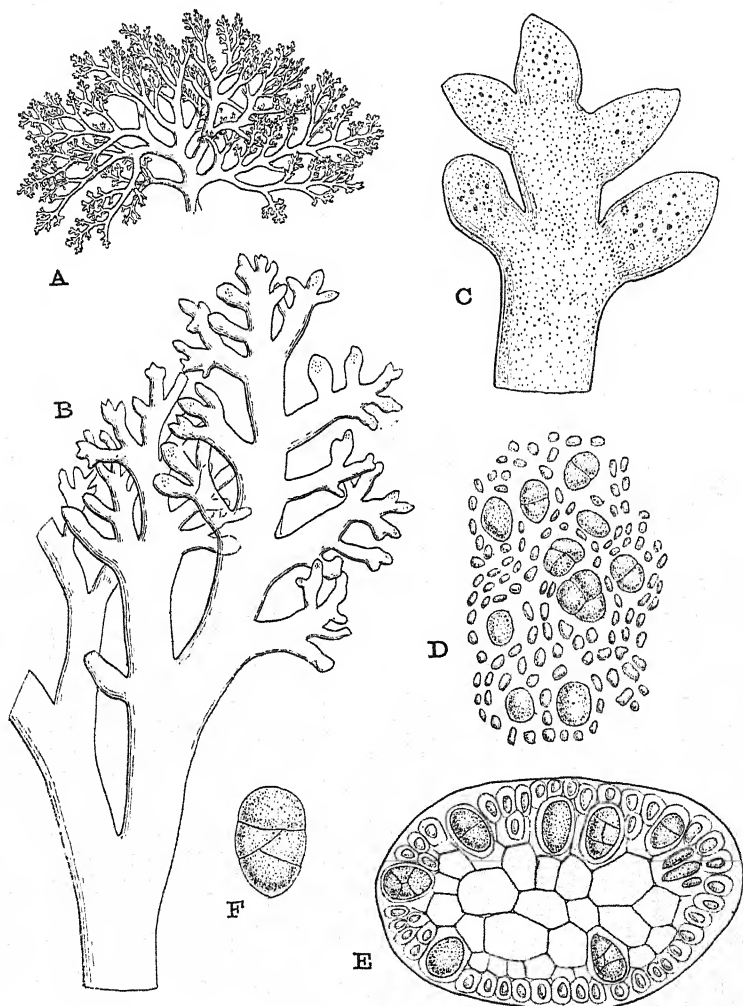


Fig. 252.—*Euthora cristata* J. G. Agardh. A. Plant ($\times \frac{3}{8}$); B. Portion of the same with tetrasporang. ($\times 10$); C. Apices of tetrasporic plant ($\times 33$); D. Surface view of portion of the same with tetrasporang. ($\times 300$); E. Transverse section through thallus showing tetrasporang. ($\times 300$); F. Single tetrasporang. ($\times 600$).

by a zone of small assimilative cells. Cystoc. on the margin of the frond, spherical, sessile; tetrasp. irregularly zonate or obliquely cruciate.

E. cristata J. G. Agardh (*Rhodymenia cristata* Grev.). Lat. *cristatus*, crested.—Frond brilliant crimson-lake, soft, fan-shaped, the segments dilated upwards, repeatedly divided, from 1.75 to 2.5 cm. high (rarely more in British specimens); lesser divisions alternate, linear, lacinate at the apices, margin often fimbriate. Cystoc. scattered; tetrasp. on separate individuals, crowded near the tips of the branches.

On the stipes and attachment organs of *Laminaria*, in deep water. Very rare; Northumberland, Scotland, Orkney and Shetland Islands.

4. RHODOPHYLLIS Kütz.

(Gr. *rhodon*, a rose, and *phyllis*, foliage.)

Frond membranaceous, dichotomous with proliferous or pinnatifid margin; formed of an internal layer of large roundish or angular cells, bounded by a zone of small assimilative cells. Cystoc. external, sub-spherical, on the margin of the frond, or on lateral processes; tetrasp. zonate, immersed in the cortex of the frond or of the marginal processes.

Differing from *Rhodymenia* in the zonate division of the tetrasporang., also in the position of the carpogenic cell in the centre of the conceptacle, not at its base as in that genus.

Key.

Tetrasp. on lateral processes on the margin of the frond	<i>R. appendiculata</i> .
Tetrasp. embedded in the frond	<i>R. bifida</i> .

R. bifida Kütz. (*Rhodymenia bifida* Grev.). Lat. *bifidus*, divided into two parts.—Frond clear rose-red, 2–10 cm. high, growing in globose tufts, dichotomously divided from the base, veinless, thin, delicately membranaceous; segments linear or cuneate, apices obtuse, margin entire and plane, or fringed with minute processes, sometimes lengthening into leafy prolongations. Cystoc. generally abundant, sessile on the margin, rarely scattered on the frond; tetrasp. forming patches in the upper segments of the frond.

On rocks and algæ beyond the tide-marks. Not uncommon; S. England, W., S. and E. Ireland.

var. **incrassata** Harv. (var. *latifrons* Holm. & Batt.).—Frond thicker than usual, broad, shrinking and becoming brownish red in drying; segments cuneate, proliferous or ciliate at the margin. Rare; S. England and Ireland.

R. appendiculata J. G. Agardh (*Rhodymenia bifida*, var. *ciliata* Harv.). Lat. *appendicula*, small appendage.—Fronds

brownish red, opaque, 2-5 cm. long, narrow, much divided; lower segments cuneate, upper segments linear; margins fringed

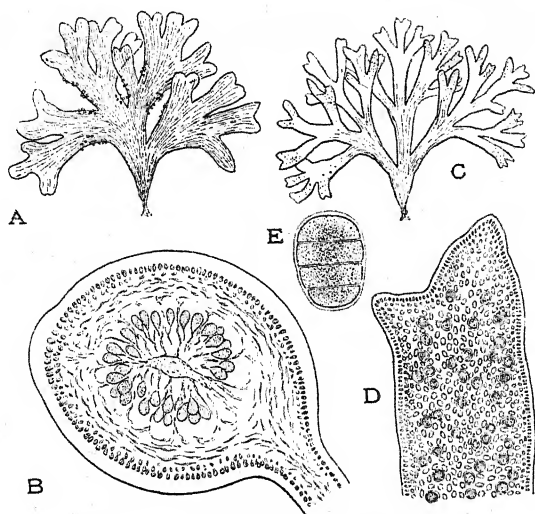


Fig. 253.—*Rhodophyllis bifida* Kütz. A. Plant bearing marginal cystocarps ($\times 3$); B. Longit. sect. through cystocarp ($\times 60$); C. tetrasporic plant ($\times 3$); D. Surface view of apices showing tetrasporang. ($\times 30$); E. Single tetrasporang. ($\times 300$).

with leafy processes, often 2-5 mm. long. Cystoc. replacing marginal processes; tetrasp. in the lateral processes.

Rare; widely distributed.

Family III.—CHOREOCOLACACEÆ

Plants holoparasitic, without chlorophyll; soma much reduced, consisting of a larger portion external to the host and a smaller portion consisting of much-branched haustorial filaments ramifying among the tissues of the host; larger portion formed of branched filaments enclosed in a gelatinous membrane, forming a subspherical flattened cushion. Carpogonial ramuli laterally inserted; carposporophyte dorsiventral, arising from a true auxiliary cell.

1. *CHOREOCOLAX* Reinsch

(Gr. *chorcin*, to penetrate, and *kolaks*, a parasite.)

Thallus parasitic, minute, forming a sub-hemispherical cushion, attached by numerous rhizoids which penetrate the host;

structure cellular, cells in radial rows. Tetrasp. cruciate, immersed in the outer layers of the cortex; plants dioecious, antherid. lining the superficial layer of the thallus; cystoc. projecting or sub-convex, borne in the outer layers, opening by an apical ostiole.

Key.

Cells of the pustule $28-34\mu$ by $2.5-4.5\mu$, parasitic on <i>Polysiphonia</i>	<i>C. Polysiphoniæ</i> .
Cells of the pustule $33-45\mu$ by $13-20\mu$, parasitic on <i>Ceramium</i>	<i>C. tumidus</i> .

C. Polysiphoniæ Reinsch.—Cushion whitish brown, variable in size, globose or hemispherical, regular or lobed; endophytic cells $3.5-11\mu$ broad, cells of the cushion $28-34\mu$ by $2.5-4.5\mu$.

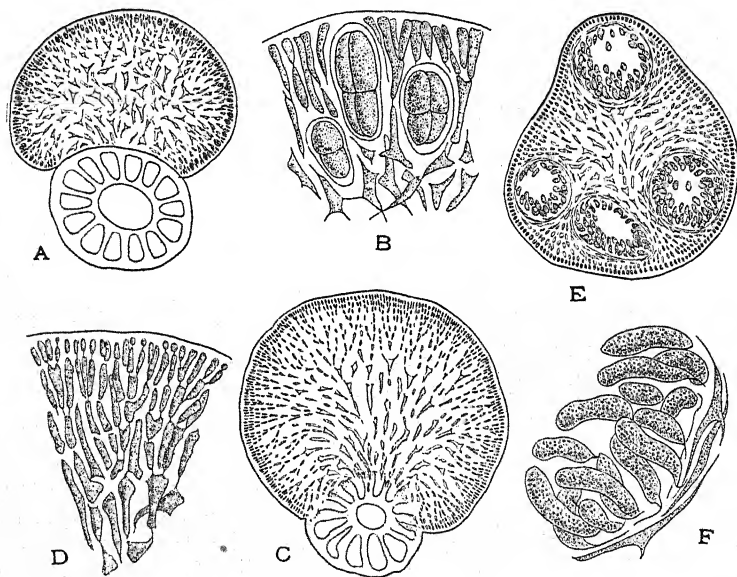


Fig. 254.—*Choreocolax Polysiphoniæ* Reinsch. A. Trans. sect. of *Polysiphonia* with tetrasporic pustule of *Choreocolax* ($\times 60$); B. Portion of margin of same ($\times 300$); C. Trans. sect. of *Polysiphonia* with antheridial pustule of *Choreocolax* ($\times 60$); D. Portion of margin of same ($\times 300$); E. Trans. sect. of cystocarpic pustule ($\times 60$); F. Group of cystocarps ($\times 300$).

Tetrasporang. 45μ by 28μ , rarely 80μ by $15-20\mu$; carpogonial ramulus consisting of three cells and a trichogyne; antherid. lining the whole surface of the external soma in distinct tufts.

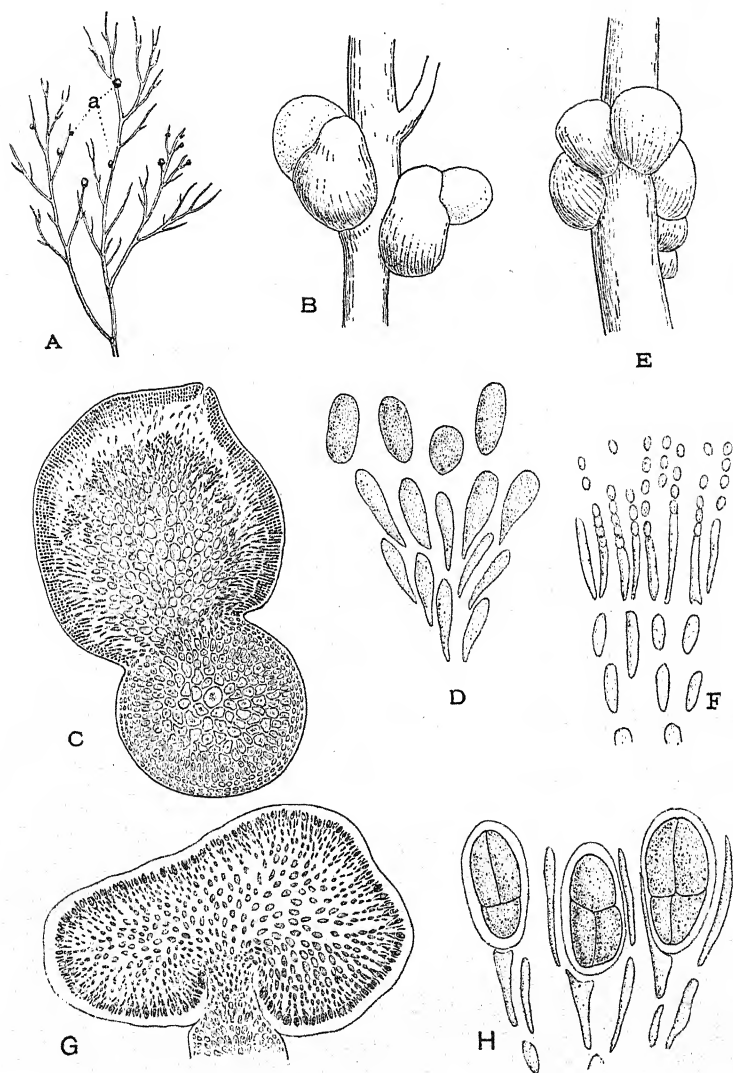


Fig. 255.—*Harveyella mirabilis* Schmitz & Reinke. A. Portion of *Rhodomela subfusca* with *Harveyella* (a) ($\times \frac{1}{3}$); B. Cystocarpic thalli ($\times 12$); C. Trans. sect. of host with cystocarp of parasite ($\times 40$); D. Group of carpospores ($\times 400$); E. Antheridial thalli ($\times 12$); F. Portion of trans. sect. of same ($\times 400$); G. Trans. sect. of tetrasporic thallus ($\times 45$); H. Margin of thallus with tetrasporangia ($\times 420$).

In fronds of *Polysiphonia fastigiata*. Not uncommon; widely distributed.

C. tumidus Reinsch. Lat. *tumidus*, swollen.—Cells of the cushion $33-45\mu$ by $13-20\mu$.

Parasitic on *Ceramium involutum*. Berwick and Butc.

2. **HARVEYELLA** Schmitz & Reinke

(After W. H. Harvey, Irish algologist.)

Thallus parasitic, forming a pustule on other algæ, branched filaments penetrating thallus of host. Cystoc. plano-convex, with shallow interior; antherid. over whole surface of frond; tetrasp. irregularly cruciate, peripheral.

Distinguished from *Choreocolax* in that the thallus is composed of subdichotomously branched filaments instead of cells arranged in fairly distinct rows and from *Holmsella* by the fact that an auxiliary cell is cut off from the subtending cell of the procarp. after fertilisation, while the carposporophyte consists of a layer of free elongated filaments without further secondary connections with the thallus cells.

H. mirabilis Schmitz & Reinke. Lat. *mirabilis*, wonderful.—Cushion more or less hemispherical, up to 2 mm. diam., often white when fresh, sometimes brownish; external soma surrounded by a thin membrane. Haustorial ramifications very largely developed between and in the cells of the host. Vegetative cells $27-40\mu$ by $9-11\mu$. Carposp. ellipsoid, 17μ by 13μ ; tetrasporang. obovoid, $25-45\mu$ by $17-20\mu$.

Parasitic on *Rhodomela subfusca*. Not uncommon; widely distributed.

3. **HOLMSELLA** Sturch

(After E. M. Holmes, British algologist.)

Plants closely resembling *Harveyella* in habit, external morphology and somatic details, differing markedly in the development of the cystoc.; auxiliary cell not formed from the subtending cell of the carpogonial ramulus; carposporophyte consisting of a more or less horizontal layer of long filaments uniting by secondary connections with every cell of the vegetative thallus immediately beneath it.

H. pachyderma Sturch (*Harveyella pachyderma* Batt.). Gr. *pachydermos*, thick-skinned.—Endophytic cells $16-23\mu$ in diam.; cells of the pustule $5-5-8-5\mu$ diam.

Parasitic on *Gracilaria confervoides*. Rare; Devon and Hants.

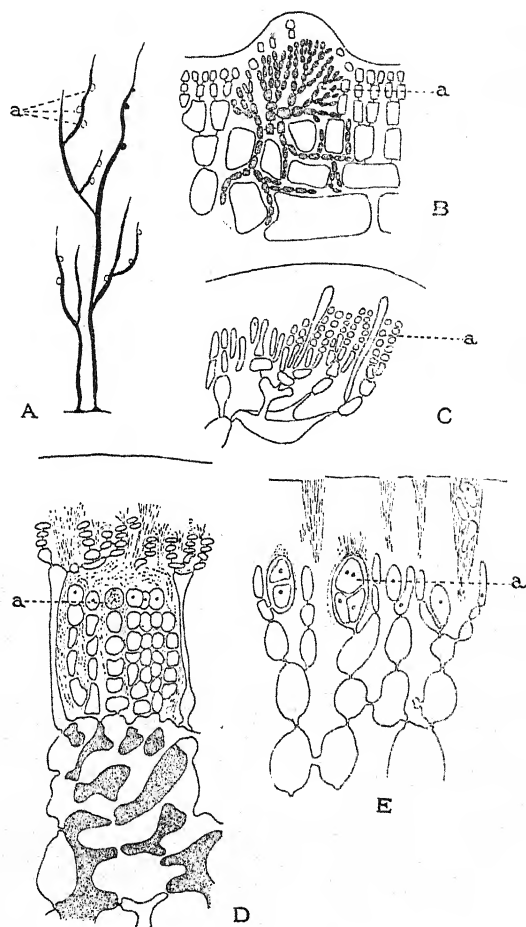


Fig. 256.—*Holmsella pachyderma* Sturch.* A. Plants (a) growing on *Gracilaria confervoides*; B. Young plant (a) (shaded) growing among cells of host; C. Antheridia and spermatia (a); D. Part of mature cystocarp. with carpospores (a); E. Development of tetrasporangia (a). (All after Sturch.)

* *Choreocolax* and *Harveyella*, have 4-celled carpogonial ramuli and an auxiliary cell cut off after fertilisation from the subtending cell of the carpogonial branch, appear to be very closely allied to the Ceramiales, while *Holmsella*, with its 2-celled carpogonial ramulus and an auxiliary cell quite remote from the subtending cell, seems fundamentally distinct and possibly should not be included in the same family. The classification adopted is the one given by Sturch (Ann. Bot. XL. 602 (1926)), to whom I am indebted for further unpublished details of an emended classification.

Order VI.—RHODYMENIALES

Life-histories varying considerably within the group ; auxiliary cell formed before fertilisation ; procarp present.

Family I.—SPHÆROCOCCACEÆ

Gonimoblast usually a hemispherical mass, immersed in the thallus, borne on a thickened placenta ; ostiole usually present, spores isolated or in chains. The development of the cystoc. is not constant in the family.

1. *SPHÆROCOCCUS* Stackh.

(Gr. *sphaira*, a sphere, and *kokkos*, a berry.)

Thallus compressed, cartilaginous, two-edged, linear, branching distichous ; branches fringed with tiny proliferations, composed of a central plate of small cells running from edge to edge, with a monosiphonous axis, thickened in the centre, bounded on each side by a band of larger angular cells, diminishing in size towards

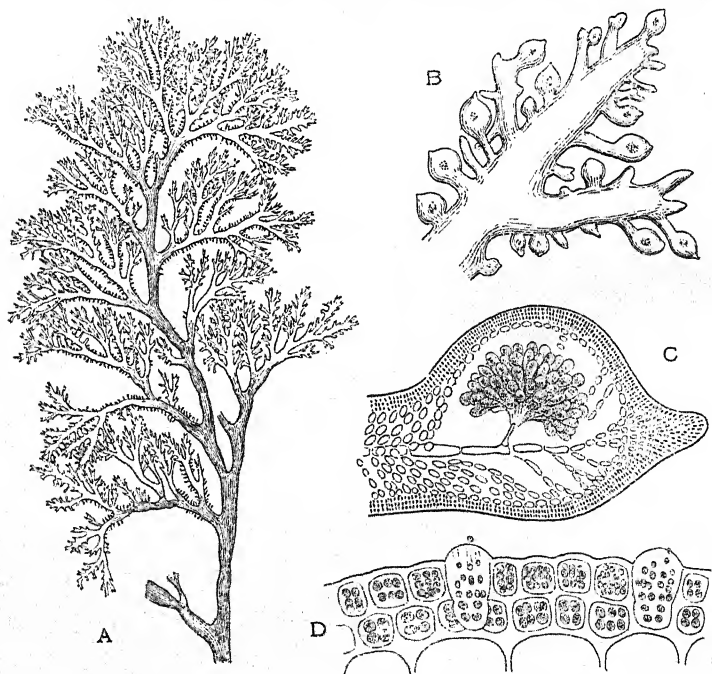


Fig. 257.—*Sphaerococcus coronopifolius* C. A. Agardh. A. Portion of thallus ($\times \frac{2}{3}$); B. Apices of thallus with marginal cystocarps ($\times 10$); C. Longit. sect. of cystocarp. ($\times 66$); D. Trans. sect. of thallus with antheridia ($\times 400$).

the periphery, followed by a layer of small moniform cells in parallel rows at right angles to the surface. Cystoc. spherical, or nearly so, embedded in the ramuli; tetrasp. zonate, formed in the cortical layer.

S. coronopifolius C. A. Agardh. Lat. *coronopus*, wart-cress (*Senebiera coronopus* Poir.), and *folium*, a leaf.—Fronde fine scarlet-pink, dark in the main branches, 15–30 cm. or more long, much branched, distichous; main axes compressed, thickened and two-edged below, becoming thinner and flatter in their upper parts, irregularly divided, alternate or sub-dichotomous, fan-shaped, multifid, ending in acute branchlets, the whole fringed with short fringe-like proliferations in which the cystoc. are borne. Cystoc. spherical, embedded in the proliferations below the apex.

Not uncommon; S. England, S. and W. Ireland, and the Channel Islands; very rare elsewhere.

Under a pocket lens the thallus appears to be traversed by a midrib, connected with the margin by oblique lateral veins.

2. GRACILARIA Grev.

(Lat. *gracilis*, slender.)

Fronde filiform, compressed or flattened, cartilaginous, horny when dry, dichotomous or irregularly decompound, composed of an inner core of large angular cells becoming smaller centrifugally, bounded by a zone of small assimilative cells, arranged more or less in chains at right angles to the surface. Cystoc. external, sessile, spherical or conical, with a large placenta from which the sporogenous filaments radiate; antherid. in small cavities in the cortex or superficial; tetrasp. cruciate, borne in the cortical layer.

Key.

- | | |
|----------------------------------------------------------------------------|-----------------------------|
| 1. Fronde brittle, flattened or compressed, rarely quite cylindrical | 2. |
| Fronde hard and tenacious, cylindrical | <i>G. confervoides</i> (1). |
| 2. Dull purple, greenish on exposure; usually a flattened thallus | <i>G. multipartita</i> (3). |
| Dull red; somewhat compressed but not a flattened thallus | <i>G. compressa</i> (2). |

1. **G. confervoides** Grev. (*G. dura* Tellam, non C. A. Agardh). Lat. *conferva*, filamentous alga, and Gr. *eidos*, like.—Fronde pale or deep purple-red, becoming greenish, cartilaginous, horny when dry, single or in groups, 7.5–50 cm. long, attached by a small disc and numerous rhizoidal filaments, cylindrical, gradually tapering at the apex, very irregularly branched; sometimes divided near the base into a few long, almost simple, naked branches, sometimes more or less dichotomous with many lateral branches and short ramuli, all attenuate at the apices. Cystoc. large, sessile, roundish or ovate, elongated near the ostiole; tetrasp. embedded in the surface cells of the branches.

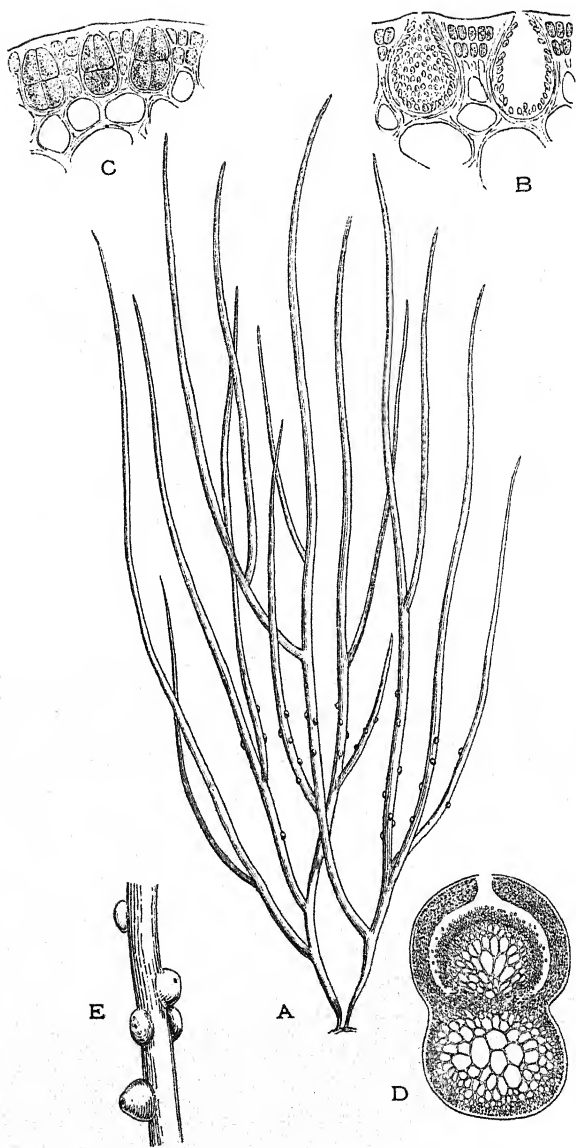


Fig. 258.—*Gracilaria confervoides* Grev. A. Plant ($\times \frac{3}{8}$); B. Section of thallus with antheridia ($\times 180$); C. Section of thallus with tetrasporangia ($\times 180$); D. Trans. sect. of thallus with cystocarp ($\times 20$); E. Portion of frond with cystocarps ($\times 2$).

On rocks and stones near low water and at greater depth. Not uncommon; widely distributed.

var. **procerrima** Turn.—Branches very long, generally simple and almost naked. Devon, Dorset, Anglesea and Bute.

var. **gracilis** Turn. (*Fucus gracilis* Stackh., *Gracilaria divergens* Holm. & Batt.).—Frond filiform, cystocarps lateral near the apices. Rare; Devon and Sussex.

2. **G. compressa** Grev.—Fronds transparent, dull red, brittle, tender and succulent, attached by a small disc, in tufts 15–30 cm. long, much branched; branches sub-compressed, sometimes nearly distichous, alternate or sub-dichotomous, rarely opposite, simple or forked, elongated, sometimes much attenuate, ending in an acute point. Cystoc. large and prominent, obtusely conical, sessile on the branches; antherid. forming small spots on the upper branches; tetrasp. embedded in the surface cells, irregularly dispersed, roundish.

Attached to *Corallines* in deep water. Very rare; S. England and the Channel Islands.

3. **G. multipartita** J. G. Agardh. Lat. *multipartitus*, much divided.—Frond dull purple, greenish with exposure, thick, cartilaginous, and very brittle, 10–30 cm. long, flat, cleft almost to the base, irregularly dichotomous, vaguely divided or palmate, sometimes having the lesser segments secund, often margined with horizontal proliferations; branches linear-wedge-shaped, apices acute. Cystoc. large, conical, depressed at the apex, very prominent and abundantly dispersed over the frond; tetrasp. scattered over the frond.

On rocks and stones in muddy estuarine localities, near low-water mark and at greater depth. Very rare; Cornwall and Devon.

3. **CALLIBLEPHARIS** Kütz.

(Gr. *kallos*, beauty, and *blepharis*, eyelash.)

Thallus flat, margins, and sometimes surface, bearing numerous simple or branched proliferations, giving a fringed appearance; thallus formed of large elongated cells, bounded on the outside with a layer of small, closely-packed assimilative cells. Cystoc. on the proliferations, subspherical; tetrasp. zonate, in the marginal proliferations or dispersed in cloudy patches on the frond.

Key.

Plant reaching perfection in winter, tetrasp. borne in the frond	<i>C. ciliata</i> .
Plant reaching perfection in summer, tetrasp. borne in the marginal proliferations	<i>C. lanceolata</i> .

C. ciliata Kütz. (*Rhodymenia ciliata* Grev.). Lat. *cilium*, eyelash.—Fronds purplish red, sub-cartilaginous, attached by a

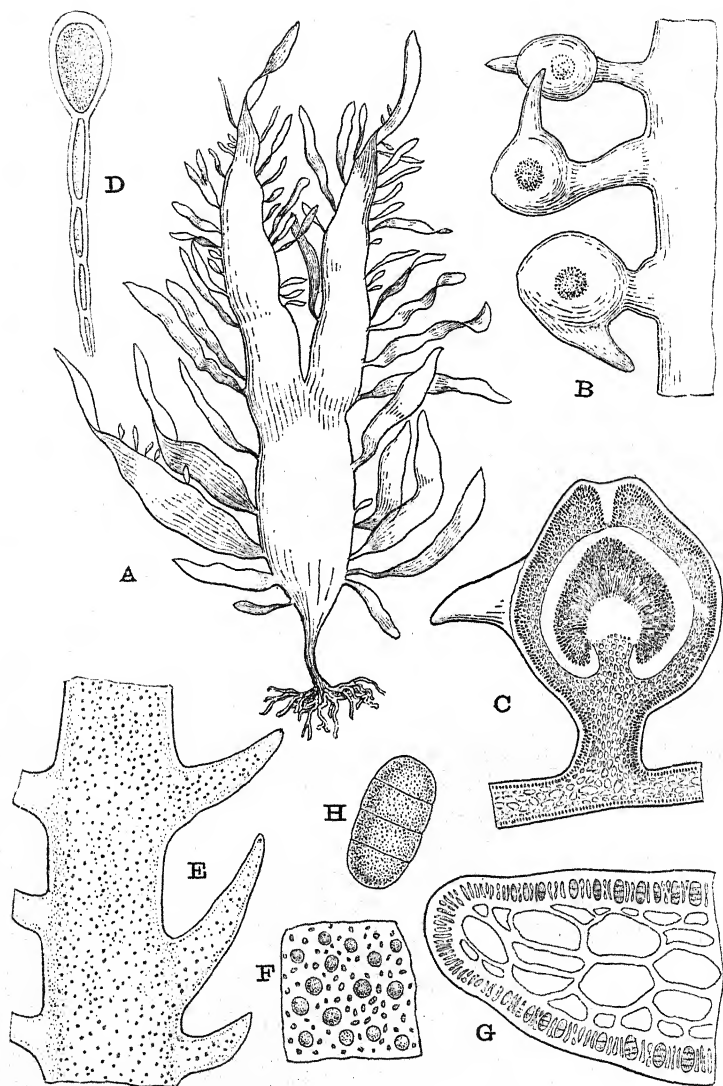


Fig. 259.—*Calliblepharis ciliata* Kütz. A. Plant ($\times 3$); B. Margin of thallus with cystocarps ($\times 12$); C. Section of cystocarp ($\times 20$); D. Carpospore ($\times 300$); E. Surface view of tetrasporic thallus ($\times 12$); F. The same ($\times 60$); G. Trans. sect. of thallus ($\times 60$); H. Single tetrasporang. ($\times 300$).

group of branching rhizoidal filaments, 15-30 cm. long, thick, stipitate, expanded above into a lanceolate or forked thallus, irregularly pinnate with lanceolate or bifid segments attenuate at the base; margin, and often the thallus too, clothed with numerous fringe-like proliferations in which the cystoc. are embedded. Tetrasp. in patches dispersed over the frond.

On rocks in pools near low-water mark and at greater depth. Often occurring in quantity early in the year, washed up after storms. Not uncommon; S. England and S. and W. Ireland and Channel Islands; rare in Scotland.

var. *angusta* Holm. & Batt.—Essex and Kent.

C. lanceolata Batt. (*Rhodymenia jubata* Grev.). Lat. *lanceola*, a small lance.—Fronds dull red, cartilaginous but flaccid, tufted, attached by a group of branching rhizoidal filaments, variable in form, stipitate below, becoming broader above, expanding into flat, linear-lanceolate, very narrow, simple or forked fronds, pinnately branched, much drawn out at the apices and clothed on the margins, and sometimes the frond too, with fringe-like proliferations, which are often much elongated and entwined round other algæ. Occasionally the frond is almost cylindrical, the branches spreading and clothed with spine-like proliferations. Cystoc. spherical, lateral, sessile on the proliferations; tetrasp. in the cilia.

On rocky bottoms of tide pools chiefly near low-water mark, also on the attachment organs of *Laminaria*; mature in summer. Not uncommon; S. England, the Channel Islands, and S. and W. Ireland.

Family II.—RHODYMENIACEÆ

Thallus growth by a cluster of apical cells; union of the auxiliary organ and carpogonial branch forms a procarp.

1. RHODYMENIA J. G. Agardh

(From *rhodon*, a rose, and *humen*, a membrane.)

Fronds flat, membranaceous, dichotomous or palmate, formed of an internal layer of oval or angular cells, bounded by a layer of small close-packed assimilative cells, sometimes superposed. Cystoc. hemispherical, external, sessile on the thallus or on marginal proliferations; antherid. in patches on both sides of the frond; tetrasp. cruciate, in the assimilative layer of the thallus.

Key.

- | | |
|-----------------------------------------|----------------------------|
| 1. Frond sessile | <i>R. corallicola</i> (2). |
| Frond attenuate below or stipitate..... | 2. |

2. Fronds 10-40 cm. long, often isolated, attenuate below but not stipitate, often proliferous *R. palmata* (3).
 Fronds 4-10 cm. long, often in tufts, stipitate, attached by rhizoidal filaments, rarely proliferous *R. Palmetta*.

1. ***R. Palmetta*** Grev.—Fronds pinkish red, membranaceous, somewhat rigid. Attached by a broad disc, often accompanied by rhizoidal filaments, tufted, 4-10 cm. long, stipitate below, compressed above, expanding into a fan-shaped semicircular lamina, cuneate below, deeply and repeatedly cleft above into dichotomous patent segments, with rounded axils and obtuse apices ;

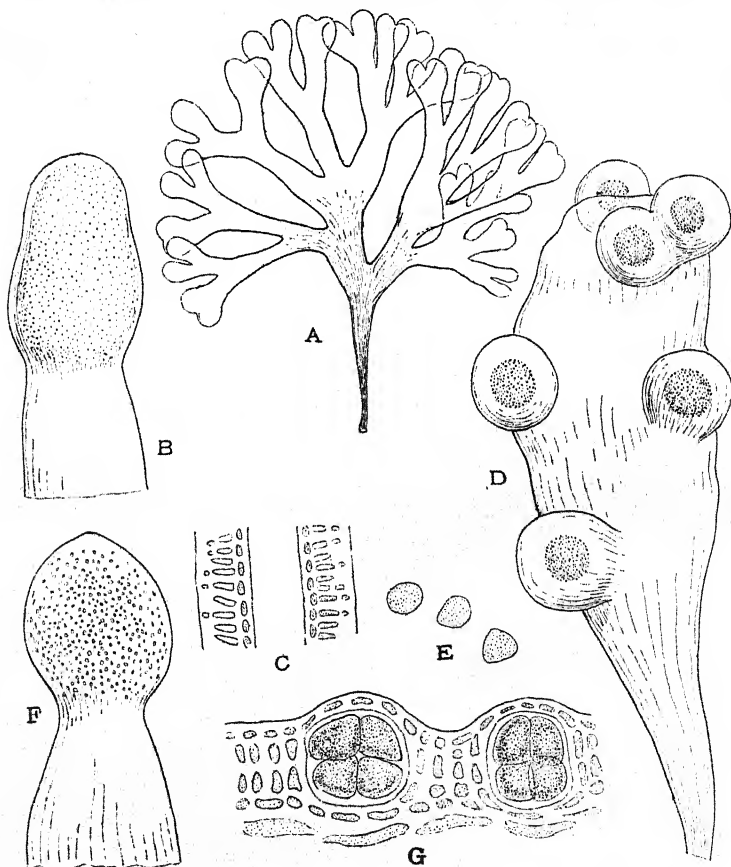


Fig. 260.—*Rhodymenia Palmetta* Grev. A. Plant ($\times \frac{3}{8}$); B. Portion of thallus with antheridia ($\times 12$); C. Trans. sect. of same ($\times 300$); D. Thallus with cystocarps ($\times 12$); E. Carpospores ($\times 300$); F. Portion of thallus with tetraspores ($\times 12$); G. Trans. sect. of same ($\times 300$).

margin entire, flat and even. Cystoc. sessile, very convex, marginal or scattered, hemispherical; tetrasp. forming red sori in the apices of the thallus.

On rocks near low-water mark and at greater depth, often on the stipes of Laminaria. Not uncommon; S. England, the Channel Islands and S. and W. Ireland.

var. *bifida* Turn.—Expanded into a sub-cuneiform thallus, generally simple or bifid. Not uncommon; S. England.

var. *crassiuscula* Turn. (f. *latifolia* Crouan).—Stipe very small, frond linear, irregularly divided with multifid acute apices. Cornwall.

var. *flabelliformis* Kütz.—Thallus reniform, lobes fan-shaped, apices rounded. Rather rare; S. England and Co. Clare.

var. *divaricata* Kütz.—Thallus cuneate at the base, dichotomous, segments all of equal length. S. England.

var. *Elisiæ* Chauv. (*Rhodymenia nicæensis* Holm., *R. Palmetta*, var. *nicæensis* C. A. Agardh).—Narrower than the type, branches attenuate at the base. Rare; S. England.

2. *R. corallicola* Ardiss. Lat. *corallum*, coral, and *colare*, to inhabit.—Frond sessile, dichotomous, fan-shaped; segments divaricate, apices obtuse or emarginate, margins often proliferous. Cystoc. hemispherical, sessile on the margins or terminal segments of the frond; tetrasp. in apical segments or marginal proliferations, forming rounded patches.

Very rare; Deal.

3. *R. palmata* Grev. Lat. *palmatus*, like the palm of the hand.—Thallus purplish or reddish brown, leathery or membranaceous, 10–30 cm. long, attenuate below but not stipitate, attached by a disc, simple or dichotomously branched, often proliferous from the margins; proliferations similar to the thallus, cuneate at the base, simple, lanceolate or obtuse at the apices or occasionally bifid; very variable in form, sometimes broadly oval or wedge-shaped, sometimes cleft into a few segments, sometimes divided into narrow ribbons. Cystoc. unknown; antherid. in patches on both sides of the thallus (February to June); tetrasp. half immersed in the frond, forming large cloudy patches.

On rocks within the tide-marks and on stipes of the larger algæ. Very common; widely distributed.

This plant is the Dulse of the Scots and Dillisk of the Irish, used by the peasants after having been dried. It was eaten uncooked, and among the poorest peasants of the west coast of Ireland has been said to have been the only addition to potatoes in many of their meals. The membranaceous form of the plant, growing on mussel-shells between the tide-marks, was the most sought after. Dulse was considered to have medicinal properties.

var. *marginifera* Harv.—Frond oblong, subsimple, proliferous at the margin. Common; widely distributed.

var. **sarniensis** Grev.—Frond laciniated, the segments narrow and sublinear. Not uncommon; widely distributed.

var. **simplex** J. G. Agardh.—Frond undivided, wedge-shaped. Common.

var. **sobolifera** J. G. Agardh.—Frond stipitate, membranaceous, branches very narrow below, much divided, expanding upwards into wedge-shaped, jagged and lacinate lobes. Rather rare; widely distributed.

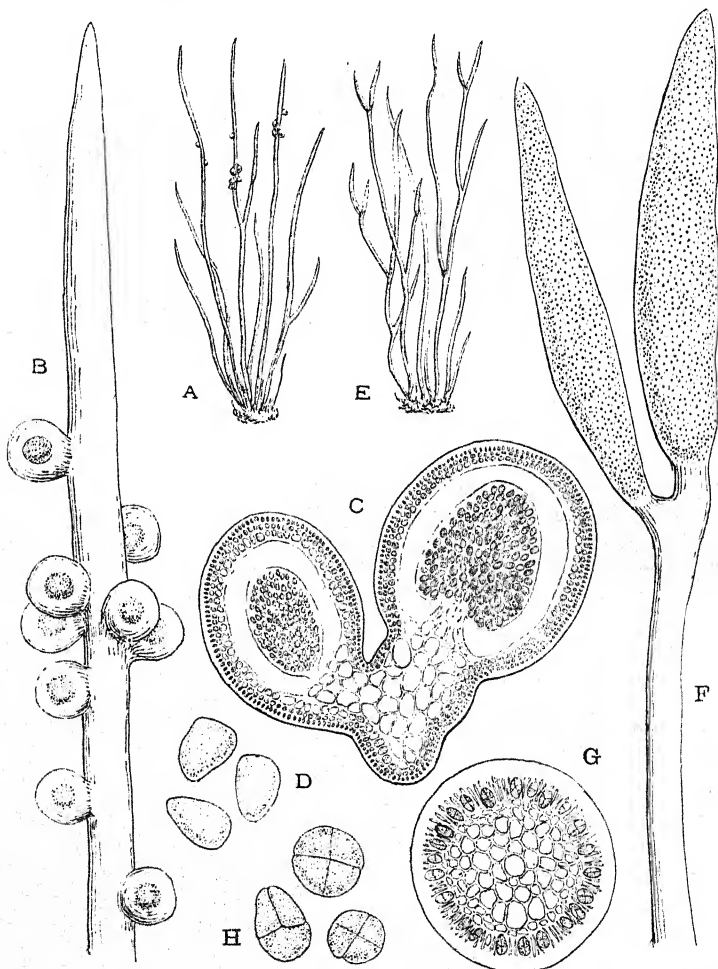


Fig. 261.—*Cordylecladia erecta* J. G. Agardh. A. Cystocarpic plant ($\times \frac{2}{3}$); B. Portion of same ($\times 12$); C. Trans. sect. of cystocarps ($\times 60$); D. Carpospores ($\times 300$); E. Tetrasporic plant ($\times \frac{2}{3}$); F. Portion of same ($\times 12$); G. Trans. sect. of same ($\times 60$); H. Tetrasporangia ($\times 300$).

2. CORDYLECLADIA J. G. Agardh

(Gr. *kordule*, a club, and *klados*, a branch.)

Fronds filiform, irregularly branched, somewhat cartilaginous, consisting of a medullary layer of oblong, longitudinal cells, bounded by a band of minute, roundish, subseriated, assimilative cells. Cystoc. sessile on the branches, subspherical; tetrasp. immersed in the periphery of pod-like ramuli, oblong, cruciate.

C. erecta J. G. Agardh (*Gracilaria erecta* Grev.).—Fronds more or less deep red, cartilaginous, somewhat rigid, attached by a thin spreading disc, numerous, 5–10 cm. high, cylindrical, filiform, erect, irregularly branched, sparingly dichotomous, or furnished with a few lateral branches; branches mostly simple, long, naked, often flexuous, tapering to a fine point. Cystoc. globose, very prominent, densely clustered, often near the tips of the branches; tetrasp. immersed in the periphery of lanceolate, terminal, swollen ramuli, mostly in pairs, cruciate, oblong.

On sand-covered rocks near low-water mark and in deeper water. Rare; widely distributed.

3. LOMENTARIA Lyngb.

(Botan. Lat. *lomentum*, a pod with constricted joints.)

Fronds filamentous, branching, hollow, with constricted nodes, formed of one or more layers of roundish or angular cells, and a few longitudinal filaments in the interior. Cystoc. external, sessile, with basal placenta; tetrasp. tetrahedral, in small cavities formed by the infolding of the cortex.

Key.

- | | |
|--------------------------------------------------------------------------------------------|---------------------------|
| 1. Branches constricted at intervals | <i>L. articulata</i> (1). |
| Branches attenuate at base and apex, not constricted | 2. |
| 2. Ramuli elliptical, obtuse at the apex, much constricted at the point of insertion | <i>L. rosea</i> (3). |
| Ramuli lanceolate, attenuate at base and apex ... | <i>L. clavellosa</i> (2). |

1. **L. articulata** Lyngb. (*Chylocladia articulata* Grev.). Lat. *articulus*, a joint.—Fronds dull to bright red or crimson, glossy, transparent, iridescent in deep water, membranaceous, gelatinous within; densely tufted, 15–25 cm. long, tubular, traversed by a few longitudinal filaments, constricted at intervals; the lowermost joints cylindrical, the upper elliptical, those of the upper branchlets frequently moniliform; branched from the base, primary branching dichotomous, secondary often opposite or somewhat pinnate, the ramuli frequently whorled round the nodes, particularly in the upper parts; apices attenuate, fastigate. Cystoc. sessile, obtusely conical, scattered over the upper

articulations with an apical ostiole; tetrasp. scattered through the frond.

Between tide marks, attached to rocks and algæ. Not uncommon; widely distributed.

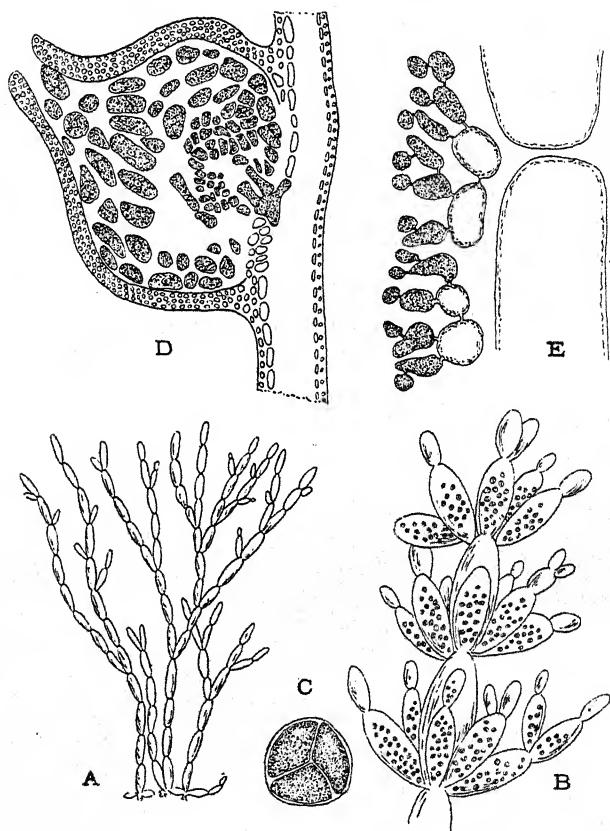


Fig. 262.—*Lomentaria articulata* Lyngb. A. Plant in March ($\times 1$); B. Plant in June with whorls of tetrasporic ramuli ($\times 6$); C. Tetrasporang. ($\times 200$); D. Longit. sect. of cystocarp with spores (after Kylin) ($\times 150$); E. Longit. sect. of thallus showing spermatia (after Kylin) ($\times 1,350$).

2. **L. clavellosa** Gaill. (*Chrysomenia clavellosa* Harv.). Lat. *clava*, a club.—Fronds bright pinky red, tender, 7.5–40 cm. long, usually with an undivided main axis, beset with lateral, patent, opposite or alternate, generally distichous branches of various lengths, themselves also pinnated with a second, third or fourth series of branchlets, the whole being clothed with lanceolate ramuli; branches and ramuli attenuate at base and apex; branching variable in density, so that the main stem is either almost naked or the whole frond a matted ball. Cystoc. obtusely conical, with apical ostiole, sessile on the branches and ramuli; tetrasp. scattered in the cortex of the branchlets and ramuli.

On rocks and stones and on other algæ near low-water mark and at greater depth. Not uncommon; widely distributed.

var. **sedifolia** Harv.—Ramuli between oblong and oval, crowded, undivided. Rather rare; widely distributed.

3. **L. rosea** Thur. (*Chrysomenia rosea* Harv.).—Frond compressed, hollow, triangular in outline, main divisions simple or once or twice forked, 3.75–7.5 cm. long, tapering at the base and apex, pinnate with simple or pinnate, opposite distichous branchlets, much contracted at the base. Tetrasp. clustered in cavities in the cortical layer of the branches.

On rocks and on other algæ in deep water. Very rare; S. England, Yorkshire and Northumberland.

var. **orcadensis** Harv.—Broader than the type. Very rare; Orkney.

4. **CHAMPIA** Lamour.

(After L. A. Deschamps, French naturalist.)

Fronds filamentous, branching, hollow, nodose, formed of one or more layers of roundish or angular cells with diaphragms at the nodes, traversed internally by a few longitudinal filaments; cystocarps external, sessile, with basal placenta; tetrasp. tetrahedral, scattered in the cortex.

C. parvula Harv. (*Chylocladia parvula* Hook.). Lat. *parvulus*, very small.—Fronds pinky or dull red, gelatinous and tender, 7.5–10 cm. long, densely matted, forming bushy tufts, intricately branched, branches opposite, alternate or whorled, nodose, joints once or twice as long as broad, apices obtuse. Cystoc. scattered, sessile, ovoid with a well-defined ostiole; tetrasp. scattered in the cortex.

Epiphytic on the smaller algæ, in tide-pools near low-water mark. Not uncommon; England and S.W. Scotland: common; Ireland and the Channel Islands.

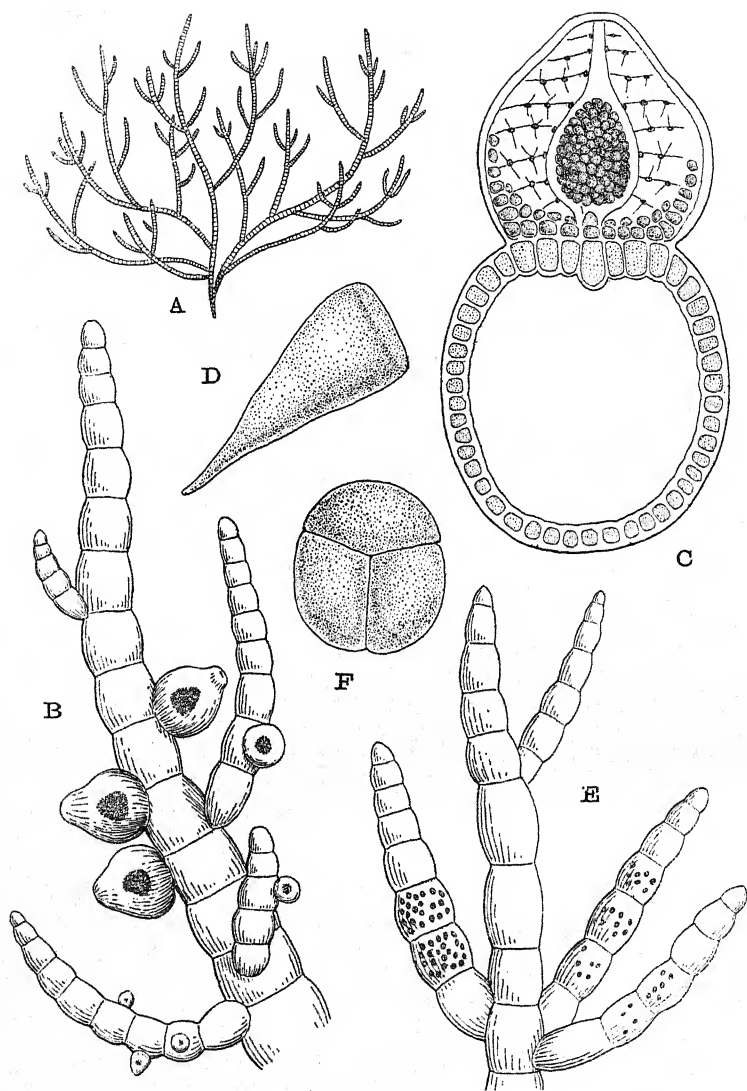


Fig. 263.—*Champia parvula* Harv. A. Plant ($\times \frac{2}{3}$); B. Portion of frond with cystocarps ($\times 12$); C. Trans. sect. of thallus with cystocarp ($\times 60$); D. Carpospore ($\times 300$); E. Portion of thallus with tetraspores ($\times 12$); F. Single tetrasporangium ($\times 300$).

5. CHYLOCLADIA Grev.

(Gr. *chulos*, juice, and *klados*, a branch.)

Thallus cylindrical, tubular (at least in the branches), constricted at regular intervals, divided into joints by internal diaphragms; outer layer formed of small polygonal assimilative cells, central portion between the diaphragms traversed by a few longitudinal filaments. Cystoc. spherical, sessile on the branches, without obvious ostiole; antherid. borne in groups projecting from the surface of the thallus; tetrasp. tetrahedral, immersed in the smaller branches near their apices.

Key.

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1. Attachment organ formed of rhizoidal branching filaments, from which a branched or unbranched naked stipe arises, several cm. long | <i>C. ovatus</i> (2). |
| Attachment organ a disc, branches and ramuli arising almost from the base or a cm. above ... | 2. |
| 2. Thallus 5-30 cm. long, branches erect, principal branches opposite or verticillate, inserted at the constrictions | <i>C. kaliformis</i> (1). |
| Thallus 2-5 cm. long, branches often recurved, irregular, often procumbent, attached at intervals by rhizoidal discs | <i>C. reflexa</i> (3). |

1. *C. kaliformis* Hook. Gr. *kalos*, beautiful, and Lat. *forma*, shape.—Fronde pinkish or purple, often with a yellow tinge, especially when growing exposed to the light, gelatinous, membranaceous; attached by minute disc, 15-30 or even 50 cm. long; main axis simple, constricted at intervals of 1.75 or 2.5 cm., furnished at each constriction with a whorl of branches similar to the axis, which may themselves bear a second or third series clothed with moniliform ramuli; general outline pyramidal, smallest above. Cystoc. globose, sessile on the branchlets; tetrasp. in the ramuli.

On rocks and stones between tide-marks, and in deeper water. Not uncommon; widely distributed.

var. *patens* Harv.—Fronde flexuous, much attenuate; branches opposite, horizontal, flexuous; ramuli setaceous, opposite or alternate. Rather rare; widely distributed.

var. *squarrosa* Harv.—Fronde crisped and entangled, variously curved; branches densely whorled; branchlets numerous, whorled, squarrose or arching, slender. Rather rare; S. England, Galway and Channel Islands.

2. *C. ovata* Batt. (*Chylocladia ovalis* Hook.). Lat. *ovatus*, egg-shaped.—Fronde brownish red, later becoming paler, cartilaginous in the stem, membranaceous and soft in the ramuli; attached by rhizoidal branching filaments, tufted, erect, 5-25 cm. long, cylindrical, of nearly equal diam. throughout, irregularly

dichotomous or alternate, the lower half naked, the upper clothed with imbricated, crowded, obovate or oblong, obtuse, saccate ramuli; ramuli usually simple, composed of a single joint, tapering below, sometimes linear-oblong, composed of several joints and bearing a second set of ramuli. Cystoc. globose,

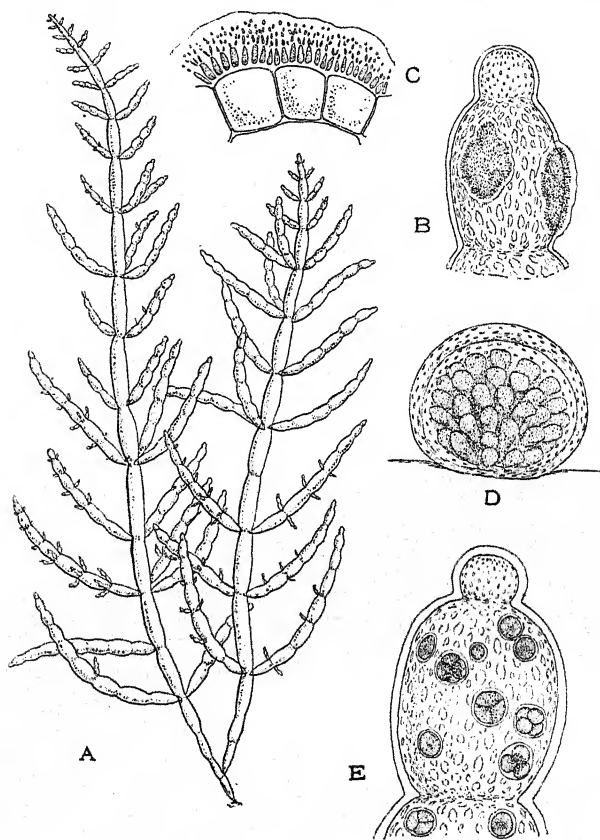


Fig. 264.—*Chylocladia kaliformis* Hook. A. Plant ($\times 1$); B. Tip of antheridial thallus ($\times 33$); C. Trans. sect. of same ($\times 300$); D. Cystocarp ($\times 60$); E. Tip of tetrasporic thallus ($\times 33$).

sessile on the sides of the ramuli; tetrasp. tetrahedral, scattered through the surface cells of the ramuli, borne on separate plants.

On rocks and stones within the tide-marks. Not uncommon; widely distributed.

var. *subarticulata* Batt. (*Gastroclonium subarticulatum* Kütz.). —Segments oblong, less sharply constricted than the type. Very rare; Devon.

3. **C. reflexa** Lenorm. Lat. *reflexus*, bent back.—Frond dull purple, membranaceous, attached by an expanded fleshy disc and rhizoidal discs developed at intervals on procumbent filaments, 5–7.5 cm. long, branched irregularly from the base; lower branches cylindrical, scarcely constricted, slender, arched, zigzag, more or less procumbent; upper branches springing from arched and procumbent ones, 2 or 3 from one point or solitary, generally unilateral, simple, spindle-shaped, moniliform, the joints becoming shorter to the tips; ramuli few, short and mostly secund, patent or recurved, rarely bifid. Cystoc. spherical on the branches; tetrasp. abundant, in the tips of the branches and ramuli.

On rocks near low-water mark. Very rare; S. England and Channel Islands.

6. **PLOCAMIUM** Lyngb.

(Gr. *plokamos*, a curl.)

Fronds compressed, membranaceous, pinnately decomposed, the pinnules alternately secund in twos, threes, fours or fives. Thallus composed of a central siphon, an inner layer of longitudinal oblong cells, bounded by a cortical layer of small, polygonal, assimilative cells. Cystoc. external, sessile or stipitate, with basal placenta; tetrasp. zonate, borne in special stichidia.

P. coccineum Lyngb. Lat. *coccineus*, scarlet.—Fronds fine clear red, cartilaginous, somewhat membranaceous, tufted 5–30 cm. long, much branched and bushy, compressed or nearly flat, two-edged, narrow, linear, irregularly divided; main axes alternating or subdichotomously branched; branches distichous, frequent, often secund, patent, bearing one or more sets of similar lesser branches; ramuli subulate, acute, patent, fringing the edges of the branches, secund, 3 or 4 at one side, then 3 or 4 at the other; lowest of each set simple, rarely crenulate along its outer edge, the rest pectinate along their inner edge with subulate teeth, which may bear a second or third series. Cystoc. solitary, sessile on the edges of axes and branches; tetrasp. in dichotomous or lanceolate stichidia, scattered along the edges of the upper branches.

On rocks and the larger algæ, generally below low-water mark. Very frequently washed up, especially after a storm. Common; widely distributed.

var. **uncinatum** C. A. Agardh.—Small, slender, flexuous, entangled and irregularly branched; ramuli patent or recurved. Rare; widely distributed.

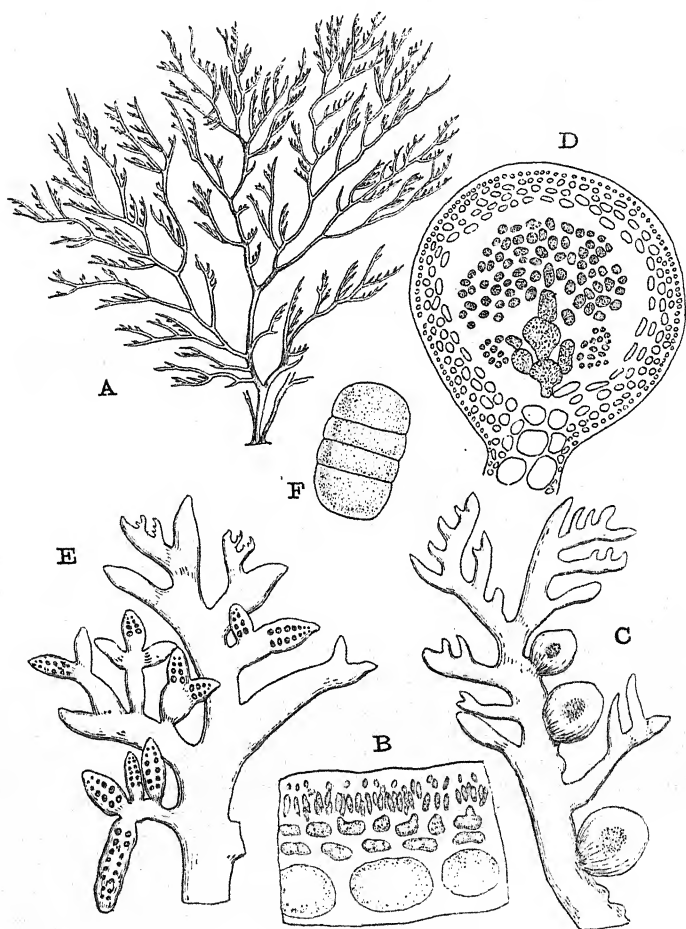


Fig. 265.—*Plocamium coccineum* Lyngb. A. Plant ($\times \frac{3}{4}$); B. Trans. sect. of antheridial thallus ($\times 430$); C. Portion of cystocarpic thallus ($\times 12$); D. Trans. sect. of cystocarp (after Kylin); E. Portion of tetrasporic thallus ($\times 33$); F. Tetrasporangium ($\times 300$).

GENERA OF DOUBTFUL AFFINITY

PORPHYRODISCUS Batt.

(Gr. *porphuros*, purple, and *diskos*, a disc.)

Fronds crustaceous, forming smooth, firm, cartilaginous, rounded expansions, closely adhering to the substratum by the entire under surface; cells of nearly equal size in all parts of the

frond, firmly united into a pseudoparenchymatous layer. Tetrasp. regularly zonate, formed in external, hemispherical or flat wart-like nemathecium.

Distinguished from *Hildenbrandia* by the external nemathecium and *Hæmatocelis* by the absence of paraphyses and the more prominent nemathecium.

P. simulans Batt.—Fronds dark shining purplish red, roundish, about 2.5 cm. diam. and from 150–300 μ thick; cells small, about as long as broad, 4–6 μ wide. Nemathecium hemispherical or flat,

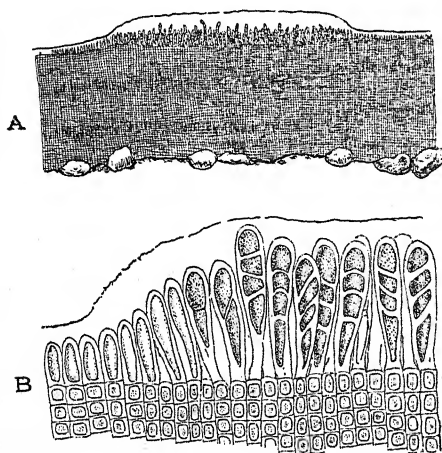


Fig. 266.—*Porphyrodiscus simulans* Batt. A. Trans. sect. of tetrasporic thallus ($\times 120$); B. Portion of the same ($\times 600$).

from 150–300 μ in breadth; tetrasp. slender, spindle-shaped, regularly zonate, 20–25 μ by 5–8 μ .

On rocks near low-water mark. Very rare; Northumberland.

HÆMATOCELIS J. G. Agardh

(Gr. *haima*, blood, and *kelis*, a spot.)

Frond horizontally expanded, crustaceous, adnate to the substratum below, cells of the basal layers superposed in radial rows, in the upper parts occurring in vertical or oblique rows, forming a pseudoparenchymatous tissue. Tetrasporang. zonately divided, borne in superficial nemathecium, interspersed by closely packed adnate paraphyses.

H. rubens J. G. Agardh. (*Hæmatophyllea Crouani* Crouan, non J. G. Agardh).—Lat. *rubens*, reddish.—Frond composed of squarish cells. Tetrasporang. ovate, elongated, nearly as long

as the paraphyses. Forming reddish or blackish red crusts on rocks and stones near low-water mark.

Differing from *Hildenbrandia rosea* in its square cells and superficial nemathecium, the tetraspores of *Hildenbrandia* being produced in cavities sunk in the surface of the frond.

Very rare ; Cornwall and Northumberland.

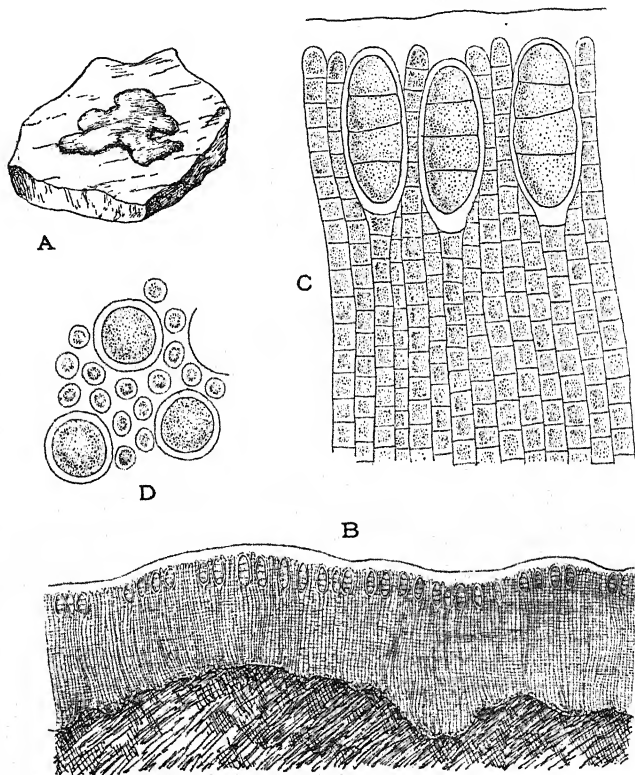


Fig. 267.—*Hæmatocelis rubens* J. G. Agardh. A. Thallus growing on rock ($\times 3$); B. Trans. sect. through tetrasporic thallus ($\times 60$); C. Portion of same ($\times 400$); D. Surface view of thallus showing tetrasporangia ($\times 400$).

RHODODERMIS Crouan

(From *rhodon*, rose, and *derma*, a skin.)

Frond membranaceous, horizontally expanded, smooth or with small protuberances, adnate to the substratum below; consisting of 2 or more rows of brick-shaped parenchymatous

cells in the vegetative parts and erect groups of paraphyses in the reproductive regions. Tetrasporang. in sori on the upper surface, oval or roundish, borne on the multicellular basal layer, interspersed with erect paraphyses; tetrasp. cruciate.

Key.

- | | |
|---------------------------------------------------------------------------------------|-----------------------|
| Thallus cells broader than long, uniform thickness throughout the frond | <i>R. elegans.</i> |
| Thallus cells longer than broad, slightly smaller near the surface of the frond | <i>R. parasitica.</i> |

R. elegans Crouan.—Frond red, encrusting, irregular in shape, consisting of 2 rows of parenchymatous cells from which erect paraphyses arise in the reproductive regions; thallus cells broader than long, of uniform thickness throughout. Tetrasporang. oval, borne in sori on the surface of the frond.

Rare; Cornwall and Devon.

var. **polystromatica** Batt.—Fronds roundish or indefinite in outline, from 1.75–30 cm. diam. composed of several cell-layers. Forming very thin crusts on rocks near low-water mark. Rare; Northumberland and Southern England.

R. parasitica Batt.—Fronds dark red, almost black, encrusting, roundish or irregular in outline, adnate to the host below;

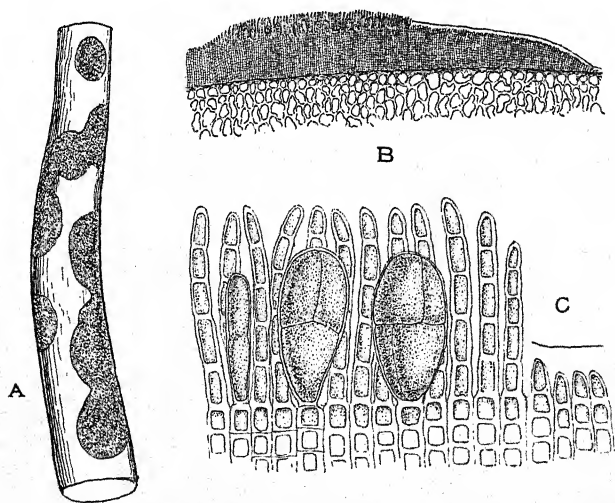


Fig. 268.—*Rhododermis parasitica* Batt. A. Colonies on *Laminaria hyperborea* ($\times \frac{1}{2}$); B. Trans. sect. of thallus on host ($\times 60$); C. Portion of same showing tetrasporangia ($\times 600$).

thallus varying considerably in thickness; vertical filaments of 12–30 cells, cells a little longer than broad, rather smaller near

the surface of the frond. Tetrasporang. in sori among short, free, curved paraphyses.

Encircling the stipes of *Laminaria Cloustoni*. Common; Scotland, Northern England and Ireland.

RHODOPHYSEMA Batt.

(Gr. *rhodon*, a rose, and *phusema*, a little bubble.)

Fronds gregarious, minute, dark red, hemispherical, globose or pear-shaped, sometimes more or less plicate-rugose, composed of a medullary stratum of large, roundish-angular, colourless cells, becoming smaller towards the periphery, and a cortical portion formed of a few layers of small, coloured, closely packed cells, each containing several small disc-shaped chromatophores. Tetrasporang. cruciate, borne in external convex sori, accompanied by slender, rigid, falcate, few-celled paraphyses; cystoc. and antherid. unknown.

R. Georgii Batt. After Edward George, British collector.—Fronds purplish red, 100μ to 1 mm. diam., clustered in dense

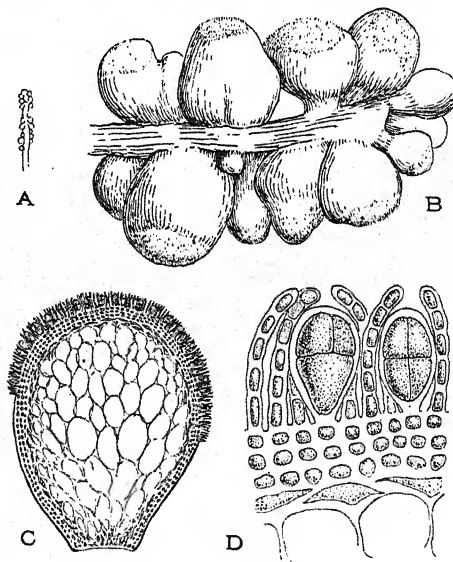


Fig. 269.—*Rhodophysema Georgii* Batt. A. Colonies on *Zostera* ($\times \frac{1}{3}$); B. The same ($\times 33$); C. Longit. sect. of tetrasporic thallus ($\times 60$); D. Portion of same with tetrasporang. ($\times 400$).

masses, more or less confluent, smooth, somewhat lubricous; cortical cells seen from above roundish polygonal, about 6μ diam. Sori $50\text{--}300\mu$ broad; tetrasp. oblong, sessile, $20\text{--}36\mu$ long,

14–18 μ broad; paraphyses 3–4 celled, somewhat clavate; cells 6–9 μ long, 3–4 μ broad.

On *Zostera*, fringing the leaf-margins with a purplish red border. Very rare; Cornwall, Devon and Dorset.

ERYTHRODERMIS Batt.

(Gr. *eruthros*, red, and *derma*, a skin.)

Fronds membranaceous, horizontally expanded, orbicular or indefinite in outline, adhering closely to the substratum, monostromatic or composed of very few layers of polygonal cells arranged in dichotomous rows, flabellately radiating from several points; plastids small, disc-shaped, several in each cell. Tetrasp. cruciate, arranged in moniliform, simple or forked filaments, packed together in external convex nemathecium; antherid. and cystoc. unknown.

E. Alleni Batt. After Dr. E. J. Allen of Plymouth Mar. Biol. Station.—Fronds 6–7 mm. diam. and about 15 μ thick; cells

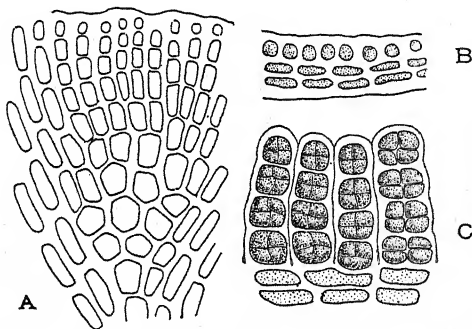
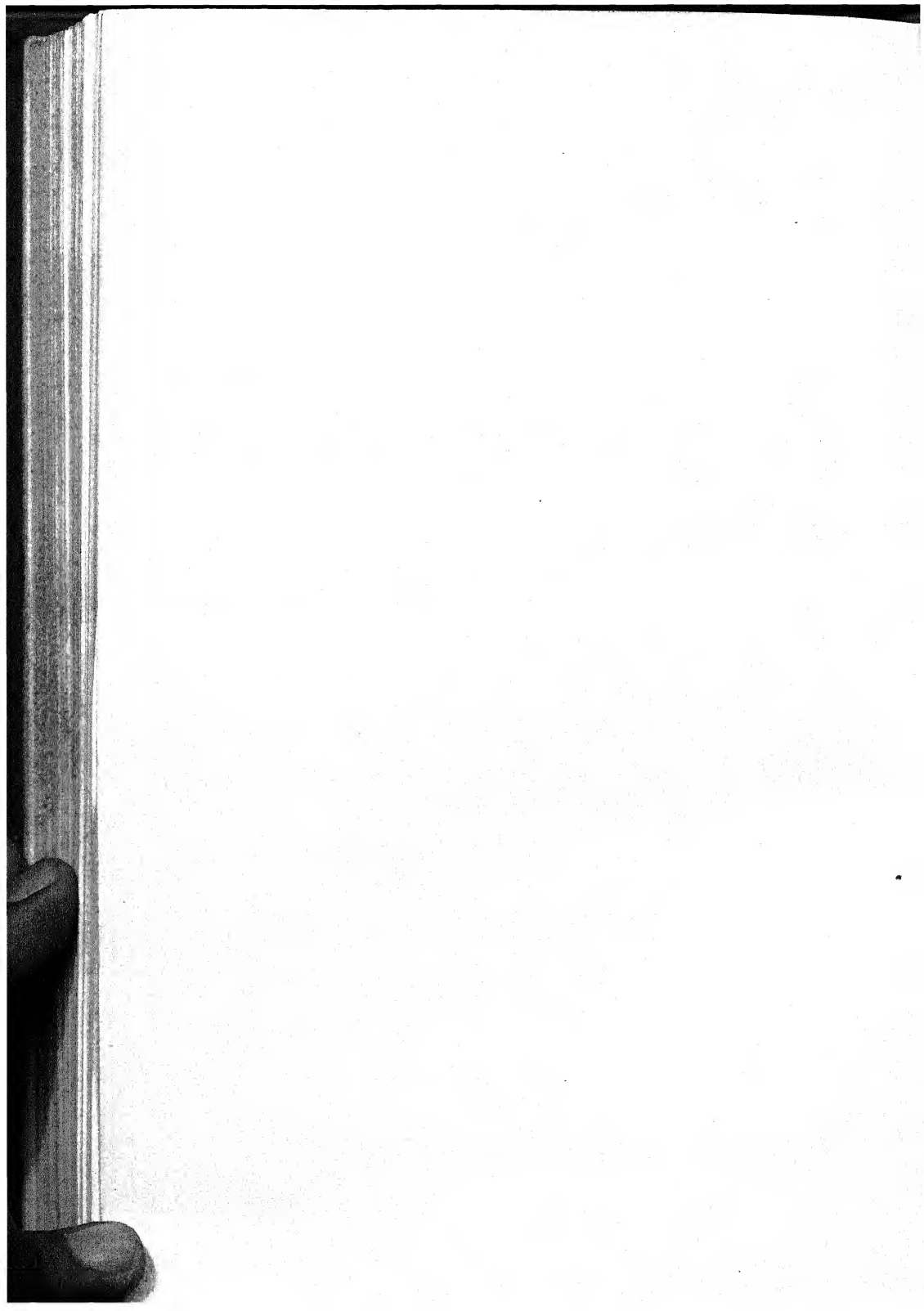


Fig. 270.—*Erythrodermis Alleni* Batters. A. Surface view of thallus ($\times 400$); B. Trans. sect. of thallus ($\times 400$); C. Trans. sect. showing tetrasporangia ($\times 400$).

6–12 μ by 6–9 μ ; nemathecium slightly elevated, about 1 mm. diam.; nemathecium filaments simple or branched, each formed of 4–6 tetrasp., 9–12 μ diam.

On pieces of broken earthenware dredged from 4–6 fathoms of water. Very rare, obtained only by dredging; Plymouth.



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GLOSSARY

- ACUMINATE (*acumen*, a point) *, having a gradually diminishing point.
- ADNATE (*adnascor*, grow to), attached the whole length.
- ADRESSED (*ad*, to : *pressus*, kept under), lying flat for the whole length of the organ.
- AIR-BLADDER, inter-cellular space acting as a float.
- ANASTOMOSE (Gr. *anastomosis*, an opening from one sea into another), communicating by cross-connexions.
- ANTHERIDIUM (Gr. *antheros*, flowering ; *eidōs*), the male sex-organ.
- APPRESSED, addressed.
- ARCUATE (*arcus*, a bow), bent like a bow.
- ARTICULATION (*articulus*, a joint). Strictly, of the joint itself ; commonly, of the segment between successive joints. When a thallus consists of a chain of cells, each cell is called an articulation.
- BASIPETAL (*basis*, foundation ; *peto*, I seek), growth in the direction of the base.
- BIPINNATE (*bi*, twice ; *pinnatus*, feathered), when both primary and secondary divisions are pinnate.
- BYSSOID (Gr. *bussos*, fine flax), composed of fine threads.
- CAESPITOSE (*caespes*, turf), tufted.
- CALCAREOUS (*calx*, chalk), containing carbonate of lime.
- CALYPTRA (Gr. *kaluptra*, a veil), the thickened membrane of the end cell (Myxophyceae).
- CAPILLARY (*capillus*, a hair), slender, hair-like.
- CAPITATE (*caput*, a head), pin-headed.
- CARPOGONIUM (Gr. *karpos*, fruit ; *gone*, offspring), the egg-cell in the Rhodophyceae, borne on a carpogonial branch.
- CARTILAGINOUS (*cartilagineus*, gristly), hard, tough, and elastic.
- CILIA (*cilium*, eyelash), vibratory hairs by which zoospores and gametes move.
- CLAVATE (*clava*, a club), club-shaped.
- CONCEPTACLE, a superficial cavity opening outwards, within which reproductive cells are borne.
- CONSTRICTED, drawn together, contracted.
- CORDATE, heart-shaped.
- CORIACEOUS (*corium*, leather), leathery.
- CORYMB (Gr. *korumbos*, a cluster of berries), a flat-topped cluster.
- CORYMBOSE, arranged in corymbs.
- CRUCIATE, cross-shaped.
- CRUSTACEOUS, hard and expanded, often brittle.
- CUNEATE (*cuneus*, a wedge), wedge-shaped.
- CYSTOCARP (Gr. *kustis*, cavity ; *karpos*, fruit), a reproductive body in the Rhodophyceae bearing either tetraspores or carpospores, formed as a result of the fertilisation of the carpogonium.
- DECUMBENT, lying flat, but with summit ascending.

* Derivations from Latin unless otherwise stated.

- DENTATE (*dens*, a tooth), toothed.
- DENTICULATE, minutely toothed.
- DICHOTOMOUS (Gr. *dicha*, in two ; *tomos*, a cut), branched by repeated forkings.
- DIFFLUENT (*diffluere*, to flow in different directions), readily dissolving.
- DIOECIOUS (Gr. *di*, two ; *oikos*, a house), unisexual, the male and female organs borne on different individuals.
- DISTICHOUS (Gr. *distichos*, of two rows), disposed in two vertical ranks.
- DIVARICATE (*divaricatus*, spread asunder), extremely divergent.
- EPIPHYTIC (Gr. *epi*, upon ; *phuton*, a plant), growing on another plant, but attached to the surface only.
- FALCATE (*falx*, a sickle), sickle-shaped.
- FASCICULATE (*fasciculus*, a little bundle), tufted.
- FASTIGIATE (*fastigium*, a gable), with parallel, clustered and erect branches.
- FILAMENT (*filum*, a thread), a chain of cells, placed end to end.
- FILIFORM, thread-like.
- FLABELLATE (*flabellum*, a fan), fan-shaped.
- FLACCID, limp, flabby.
- FLEXUOUS, bent alternately in opposite directions.
- FROND (*frons*, a leaf), the expanded thallus.
- FUSIFORM (*fusus*, spindle), spindle-shaped, tapering at the extremities.
- GELATINOUS (*gelatus*, congealed), jelly-like.
- GONIDIUM (*gonos*, off-spring), propagative-cell, asexually produced.
- HABIT (*habitus*, appearance), the general form of a plant.
- HABITAT (*habitatio*, dwelling), the place of growth of a plant, its environment.
- HETEROGENEOUS (Gr. *heteros*, other ; *genos*, kind), not uniform in kind.
- HOMOGENEOUS (Gr. *homos*, the same), of the same kind, uniform.
- HYALINE (Gr. *hualinos*, of glass), colourless or translucent.
- IMBRICATE (*imbrex*, a tile), overlapping, like the tiles on a roof.
- INARTICULATE, not jointed, continuous.
- INTERNODE, the space between two joints, an articulation.
- IRIDESCENT (Gr. *Iris*, goddess of rainbow), showing rainbow-like colours.
- LAMELLATE (*lamella*, a thin scale), made of thin plates.
- LAMINA (*lamina*, a thin plate), the expanded portion of a thallus.
- LANCEOLATE (*lanceolatus*, armed with a little lance), flat, broad in the middle and narrow at each end, like a lance.
- LINEAR (*linea*, a linen thread), narrow, several times longer than wide.
- LOBE (Gr. *lobos*, the lower part of the ear), a portion of a deeply cut frond.
- MEMBRANACEOUS (*membrana*, a skin), thin and semi-transparent.
- MONILIFORM (*monile*, a necklace), like beads on a string.
- MONOECIOUS (Gr. *monos*, one ; *oikos*, house), the male and female organs borne on the same individual.
- MUCRONATE (*mucro*, sword-point), possessing a short, straight point.
- NEMATHECIUM (Gr. *nema*, a thread ; *theke*, a case), a wart-like projection bearing reproductive bodies.
- NODE (*nodus*, knot), a joint.
- OB-, used as a prefix, meaning inversely.
- OBLONG, broadly linear.
- ORBICULAR (*orbiculus*, little disk), circular, round.

- OVATE (*ovum*, an egg), having the outline of the longitudinal section of a hen's egg.
- OVoid, egg-shaped, solid.
- PALMATE (*palma*, the palm of the hand), divided like the hand, into finger-like lobes.
- PAPILLATE (*papilla*, nipple), covered with wart-like protuberances or papillæ.
- PARANEMATA (Gr. *para*, beside; *nema*, thread), paraphyses or sterile hairs.
- PARAPHYSES, paranemata.
- PARASITIC (Gr. *parasitos*, one who lives at another's expense), obtaining nourishment from another organism.
- PARIETAL (*paries*, the wall of a house), attached to a wall.
- PATENT (*patens*, spreading), spreading.
- PECTINATE (*pecten*, a comb), pinnatifid with narrow segments set close like the teeth of a comb.
- PEDICELLATE (*pediculus*, a small pot), stalked.
- PERCURRENT (*percurrens*, running through), extending through the entire length.
- PERISPORE (Gr. *peri*, about; *spora*, a seed), the spore membrane.
- PINNA (*pinna*, a feather), one of a series of opposite or alternate distichous branchlets.
- PINNULE (*pinnula*, a small feather), a secondary pinna.
- PINNATED, furnished with distichous branchlets, arranged like the plumes of a feather.
- PINNATIFID (*findere*, to split), deeply incised in a semi-pinnate manner.
- PLACENTA (a cake), the part to which the spores are attached.
- PROLIFEROUS (*proles*, offspring; *fero*, I bear), bearing progeny as offshoots.
- PROPAGULUM (*propago*, a layer, shoot), a reproductive portion of a frond which is not a spore.
- PULVINATE (*pulvinus*, a pillow), cushion-shaped.
- PYRIFORM (*pyrus*, a pear), pear-shaped.
- QUATERNATE (*quater*, four times), arranged in fours.
- RACEMOSE (*racemus*, a bunch of grapes), having racemes, here used to mean having stalked cytocarps along a branchlet.
- RAMULUS (a little branch), a minute branch, usually, applied to the ultimate divisions of a branching frond.
- RENIFORM (*renes*, the kidneys), kidney-shaped.
- RETICULATE (*reticulus*, a little net), netted like net-work.
- REVOLUTE (*revolvere*, to roll back), rolled back from the margin or apex.
- SECUND (*secundus*, following), arranged along one side only.
- SEPTUM (a barrier), a partition.
- SERRATED (*serra*, a saw), toothed like the edge of a saw.
- SESSILE (*sessilis*, sitting), having no stalk.
- SETACEOUS (*seta*, a bristle), bristle-like.
- SILICLE (*silicula*, a little pod), a short silique, not much longer than wide.
- SILICULOSE, resembling a silicle.
- SINUATE (*sinuare*, to bend), with a deep, wavy margin.
- SORUS (Gr. *soros*, a heap), a cluster of sporangia or other reproductive bodies.
- SPERMATIUM (Gr. *sperma*, a seed), non-motile male cell.
- SPORANGIUM (Gr. *spora*, a seed; *aggeion*, a vessel), a sac in which spores are formed endogenously.

SPORE, a cell which eventually becomes free and is capable of development into a new individual.

STICHIDIUM (Gr. *stichidion*, a little row), special branch of the thallus bearing reproductive organs.

STIPE (*stipes*, a trunk), the basal stalk-like portion of a thallus.

STIPITATE, having a stipe.

SUBULATE (*subula*, a shoemaker's awl), awl-shaped.

TERETE (*teres*, rounded), round in section.

TERNATE (*terni*, three together), in threes.

TETRAHEDRAL (Gr. *tetras*, four) (of tetraspores), when only three of the spores can be seen in one view.

TETRASPORANGIUM, a unicellular sporangium containing tetraspores.

TETRASPORE, a spore formed by the division of the spore mother-cell into four parts.

TORULOSE (*torus*, a round, swelling protuberance), cylindric, with swellings at intervals.

TRICHOTOMOUS (Gr. *trichia*, in three ; *tome*, a cutting), dividing continually in threes.

TRUNCATE (*truncare*, to shorten by cutting off), terminating abruptly as if broken off.

TUBERCLE (*tuberculum*, a little swelling), a small excrescence.

URCEOLATE (*urceolus*, a small pitcher), shaped like a pitcher with a protruding mouth.

VAGINATE (*vagina*, a sheath), sheathed.

VIRGATE (*virga*, a rod), long and straight like a wand.

WHORLED, surrounding a branch, in a ring.

ZONATE (Gr. *zone*, a girdle) (of tetraspores), when the tetrasporangium is divided transversely by three parallel walls.

ZOOSPORE (Gr. *zoon*, an animal ; *spora*, a seed), asexual reproductive cell with power of movement by means of cilia.

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